ELECTRICAL REVIEW

[ILLUSTRATED.]

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Light for the Battle Field.

Just at the present time, when war clouds are hanging thick and heavy over Europe, and more or less exaggerated rumors of war are filling the columns of our daily press, it is not surprising to read of new inventions made in the interest of army soldiers. Only a short while ago the Prussian War Department announced a competition for a portable military barrack, open only to German architects and civil engineers. And now a novel application of the electric light to military hygiene of the battle field is said to have been made in Wurtemburg. According to Mr. Nachtigal, a German army surgeon, a light ambulance wagon, easily drawn by two horses, has been constructed, which is equipped with an electric light of two thousand candle power, generated by means of a dozen galvanic batteries, which last for continuous illumination during a whole night. The arc lamp is suspended from an adjustable truck, not unlike some of our patented portable fire-escape apparatus, and the light hangs so that it may be turned free in all directions, which is necessary, inasmuch as a parabolic reflecting mirror is placed behind the light in order to increase its power of illumination. Experiments made during the late maneuvers with such an ambulance wagon demonstrated the possibility of successfully lighting a battle field to a distance of nearly half a mile from the ambulance to such an extent as to enable the search for and discovery of the bodies of dead or wounded soldiers, partly hidden from view by shrubbery. It is said that the ambulance wagon is so strongly built that it may readily be driven across fields and meadows without interfering with the proper working of the electric arc light.

Patent Heat Regulating Apparatus.

In the illustrations on this page are shown the Lee heat regulating apparatus designed to place the furnaces of residences and other buildings under such perfect control that an almost absolute even temperature may be maintained through the entire cold season. It maintains the desired degree of warmth throughout the house; any variation therefrom, whether up or down, is instantly detected and corrected.

The economy of such an arrangement is evident: the furnace being checked at the precise point of deviation in temperature, there is scarcely a pound of coal burned unnecessarily, and the fire is not allowed to get too low, but an even and perfect combustion is secured. The regulator is governed by the temperature of the rooms that are being warmed. A metallic thermometer or thermostat is placed in one of the rooms or halls of the house and is connected by electric wires with the furnace damper which is operated electrically. A powerful and simple electro magnetic device acts directly in a peculiar manner on the damper. There is no clock work to be wound, or air pumps to be worked, while the cost of the apparatus is greatly reduced.

The working parts of the thermostat are enclosed in a neat metallic case with a handsome and accurate thermometer, on the top of which is mounted an adjustable indicator which may be moved in either direction on the scale, determining the precise degree at which the temperature will be maintained. Moving the indicator toward the left lowers, and toward the right raises the temperature. This need never be done except, perhaps, at night, when it may be desired to set it at a lower degree than during the day. The damper is simply opened and closed at a lower or higher temperature, according to the position of the indicator.

The damper as usually made for application to furnaces consists of a six or seven inch check damper placed on an off-set of the smoke pipe and checks the fire by admitting cold air into the smoke flue. It may be arranged differently when necessary. It may be applied to the heat flues of each separate room and regulate the warmth of each room independently.

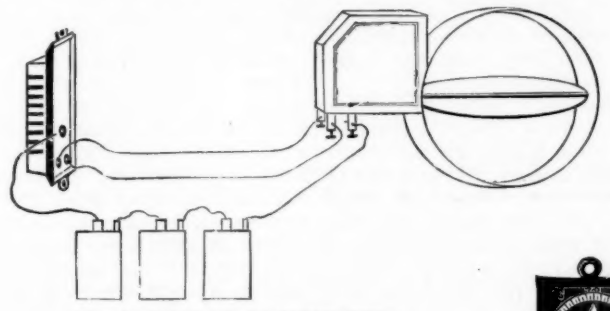
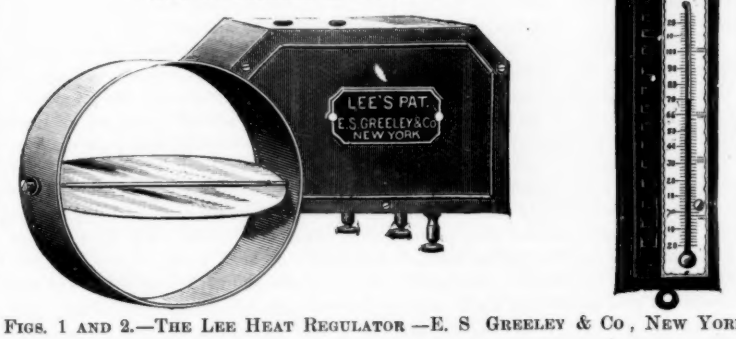


FIG. 3.—DIAGRAM OF CONNECTIONS.



FIGS. 1 AND 2.—THE LEE HEAT REGULATOR.—E. S GREELEY & CO, NEW YORK.

Big Contract for Electric Railway Cars.

The city of Richmond, Va., is not to be left behind in the onward march of electrical work. The Union Passenger Railway of that city, has just contracted with the J. G. Brill Company, Philadelphia, for 30 street cars, to be used on the electric railway of that city. The Sprague electric motor and all overhead wire will be used. This is the biggest single order yet made by any electric railway company. The Brill Company is doing an extensive business in the manufacture of electric railway cars, several other motor companies ordering from them.

—— The Utica Electric Light and Gas Company has passed into the control of the Equitable Gas Company, of this city. The president of the company is Mr. R. M. C. Graham; vice-president and treasurer, Henry Keene; secretary, Harold Graham. The new board of directors chosen consisted of Col. R. M. C. Graham, Henry Keene, Harold Graham, Chas. D. Harrison, John Fox, John D. Crimmins, J. P. Miller, A. W. P. Cramer, and E. J. Enfer. A. W. Putnam Cramer has been appointed superintendent.

The Treatment of those Suffering from the Effects of High-Tension Electricity.

M. Brown-Séquard, the eminent physiologist, made a brief communication on the above subject to the French Academy, which deserves to be carefully noted by all electricians who deal with dynamo machinery. M. Brown-Séquard, referring to a recent communication of M. d'Arsonval upon the same subject, strongly endorsed the advice that in all cases of apparent death from electric action, artificial respiration should be immediately resorted to. For some time past there has been in use at the College de France, a mode of exciting the respirative organs in cases of arrest by inhibition, which is more easily applied and far more effectual than the methods previously employed. This process consists in the application of what the medical electricians call "faradization"—that is, excitement with a small induction coil—the electrodes being applied externally on either side of the larynx. The skin of the neck should either be moistened or a superficial incision should be made in order to overcome the insulating power of the epidermis. By this means the nerves which govern the respirative organs are directly stimulated, and, if life still exists, will speedily resume their normal functions.

—— The Fisher electric motor, manufactured by the Detroit Electrical Works, is in constant and satisfactory use on a Detroit suburban street car line, and recently has been adopted in Pittsburgh, and in three Western cities. The motor is a very good one, working economically and effectively.

—— The Municipal Gas Company, of Albany, has decided to operate the electric light in certain suburban portions of the city, and has appointed Mr. William C. Miller manager of the electric lighting department. Mr. Miller is familiar with electrical work, having been connected with both the Edison and Sawyer-Man companies.

The Electric Club's Regular Meeting.

A CLUB HOUSE DECIDED UPON AND A BUILDING COMMITTEE APPOINTED.

There was the usual large attendance at the regular monthly meeting of the Electric Club last Thursday, May 19, and the evening's programme much enjoyed.

Among the gentlemen present, were E. T. Gilliland, H. C. Davis, Geo. L. Beetle, H. A. Reed, C. O. Baker, jr., Lieut. F. W. Toppan, O. Hoftman, Chas. Dutton, Col. Henry Harney, D. E. Drake, F. G. Stone, Henry Hine, Albert Taylor, George Manson, C. W. Pratt, H. R. Garden, Lieut. Andrews, M. W. Goodyear, J. B. Powell, Geo. B. Coggeshall, J. M. Pendleton, J. N. Keller, T. L. Fowler, L. N. Downs, A. V. Frost, H. D. Hall, George Worthington, New York; H. D. Stanley, Bridgeport; C. J. H. Woodbury, Boston; Stephen Holbrooke, S. B. Richards, George Porter, Philadelphia; F. A. Cheney, J. A. Powers and father, of Troy, N. Y.

The severe illness of Dr. Otto A. Moses compelled a postponement of his description of a new "Electric Seismometer," and instead Mr. J. A. Powers, of Troy, N. Y., read a very instructive and practical paper on "Construction of Electric Light Stations," which we publish in full. A vote of thanks was tendered Mr. Powers. Mr. C. J. H. Woodbury, of Boston, was called on and spoke interestingly on the same topic. His remarks appear in synopsis on another page.

The announcement was made by Chairman Dutton, of the committee appointed to arrange for summer meetings, that the next three regular meetings, commencing June 23d, would be held at the Hotel Brighton, Coney Island.

The President, Mr. H. C. Davis, then addressed the Club at some length, in relation to the matter of securing a permanent club house. He stated that the matter had been discussed at several of the former meetings of the Board of Managers, and a recent canvass made had shown a strong feeling in favor of the purchase of a building, not only on the part of the members of the club, but also on the part of a number who expected to become members, and who would take prominent part in the proposed work. Particular interest had been expressed to him in the part of the plan which comprised the education and instruction of students and beginners in electrical work. A building committee had been appointed (to which the Club later on added several names) to act with the Board of Managers. Some of the propositions, the President stated, were as follows:

Under the auspices of the Electric Club, it is proposed to establish a training school, or a series of regular lectures, through which the employes of the various electrical interests can receive, without charge, instruction in their various branches, and be better fitted to perform their duties.

In connection with the insurance companies it is also proposed to establish a Board of Examination, and to require that all men in charge of electrical installations, where fire and life risks are involved, shall have a certificate, the same as is required of an

engineer, and subject to the same, or suitable penalties.

To prevent such information from being local, the lectures should be printed, in cheap form, with sufficient illustrations to make them clear, and be distributed to all who desire them, for a nominal fee, to cover postage.

The insurance companies, the electrical companies and the employes have a common interest in the success of this plan.

To put this into practical effect, the Electric Club must provide a suitable club house and lecture room, combined ; to afford the social conveniences for its members, especially the non-residents, who would find it a convenient headquarters when in the city, and to have the facilities to combine practical instruction with theoretical.

If convenience, rather than elegance, is considered, the cost of such a house would be considerably reduced, and the desired object in no way lessened in the value of its results.

The important question is how to provide the necessary funds to carry out this plan, which, when once started, it is supposed that the club membership will furnish the necessary money to meet current expenses.

The remarks of the President were loudly applauded when he sat down. It was evident that the club house proposition met with the hearty concurrence of all present.

Mr. J. N. Keller inquired what particular plan had been discussed for securing means for carrying out this project, which he heartily favored.

The President stated that several propositions had been discussed, and a final decision would probably be made at the general committee meeting next Thursday. One of the plans had been that of issuing bonds, every member to purchase to the extent he felt disposed; another, resulting from the favor with which the educational feature had met with in certain financial circles, had been that of receiving subscriptions. All plans and all suggestions should be presented at the next meeting.

The Secretary announced the completed list of names comprising the Building Committee, as follows :

W. L. Strong, E. S. Greeley, Edward H. Johnson, George Worthington, H. L. Storke, Clark B. Hotchkiss, C. A. Cheever, W. D. Sargent, W. H. Kelly, C. L. Buckingham, J. M. Pendleton, of New York; James English, of New Haven; H. G. Cheney, of Hartford ; George W. Stockley, of Cleveland ; Eugene F. Phillips, of Providence; D. L. Hungerford, of Waterbury; John I. Sabin, of San Francisco; J. N. Keller, Fred. Swift, C. J. H. Woodbury, of Boston; Alfred F. Moore, Stephen Holbrooke, of Philadelphia; J. A. Powers, of Troy, N. Y.

Central Station Construction.

By J. A. Powers.

Read Before the Electric Club, New York, May 19, 1887.

There are two ways of constructing a central station for electric lighting, each of which has its special object. They may be defined as the speculative and the investment plans. The first has as its legitimate, or rather illegitimate end, the sale of the plant to some unfortunate, perhaps unwilling, capitalist, by fair means or foul. We may consider as fair means the not uncommon method of selling a small portion of the stock, perhaps just enough to pay for the apparatus, on the strength of a showy exhibition in the hands of an expert, who uses all the tricks of the trade to persuade his lambs that his system will produce double the light with half the power of any other, and the other customary arguments.

The foul means is the border ruffian money-or-your life policy, which enters a territory already sufficiently well served, not for fair competition, but to make money by being bought out.

The electric light business is rapidly emerging from the border ruffian and blackmailing stage, and, as we may shortly expect these methods to be relegated to their proper realm with other things dead and dishonorable, with the growth of popular knowledge of electrical matters, we will leave them and proceed to the more legitimate methods, which I hope you will all pursue.

"The fool doth think he is wise, but the wise man knows himself to be a fool," said the master of all writers, and that I may be saved entering the first class in your presence, I here confess to many and grievous mistakes in our own central station construction, to which this paper owes its being, for that I may hope to save some of you part of my errors is my only excuse in appearing before you.

Let us then drop speculation as a thing of the past in our business, and make our object the construction of such work as shall produce to the sober judgment of every business man among you, the best results in economy of labor, supplies and power, with the least expenditure for interest, taxes, insurance and repairs.

In all manufacturing enterprises of the day, one tendency is unmistakably felt. It is the direction of thorough work. To succeed in any established business one must have substantial buildings, the best improved machinery, the best site for obtaining necessary supplies at their cheapest. Electric lighting to-day has risen from the slough of speculation and stands side by side with other great manufacturing enterprises in importance. Not less than sixty millions of dollars are invested in lighting plants alone, and in the entire field probably not less than double that sum. Has not the time come when the same laws of strict economy which obtain in other large enterprises should govern central station construction ?

Let us carefully consider our problem, plan cautiously, and expend liberally in the directions which indicate the best results. It is evident, however, that we should not expend without limit. Where shall we draw the line ? I believe we are safe in expending every dollar which is sure of saving 10 per cent. interest on its investment, provided we have it to spend. The only danger in the path seems to be the chance of such improvements as shall throw aside our present methods of producing electricity. Let us for a moment consider the possibilities in this direction. The best dynamos will to-day, in ordinary practice, convert eighty to eighty-five per cent. of the power furnished them into an equivalent of electricity. Clearly there can be but small improvement here. Coal or similar fuel is the common source of power to-day, and seems likely to remain so. The best steam plants give one horse power hour for about one and one-half pounds of coal. The actual energy stored in that pound and one-half of coal would give about seven horse power hours if it could be converted into power without loss, or, in other words, the best steam plants of to-day have an efficiency of about 13 per cent.

Professor Houston remarked, at the last convention of the National Electric Light Association, that the field where lies the greatest chance for improvement is in the direction of thermo-electricity, the conversion of heat into electricity without the intervention of power. This is most certainly so; for if a process can be discovered which will have a reasonable efficiency, say 25 per cent., electric motors must soon supersede steam engines for power. The nature of the losses connected with the conversion of heat into other forms of energy does not, however, give much encouragement in this direction. The nature of such losses is in the diffusion of heat by conduction and radiation, which has always proved most difficult of control. If a process of simple conversion, without the attendant development of heat, can be devised, the chances of a good efficiency would be much improved; but where heat exists, there is radiation, and where radiation is, there will be serious loss. How serious, we can only judge from our experience with the steam and other heat engines. It is probable that we are safe in investments in our expensive steam plants, at least to the extent of the life of these plants. Let us then return to our subject proper. The first matter of importance to be decided in establishing an electric light station is its location. The necessary qualifications for location may be classed about as follows:

1st. A dry soil—a gravelly soil, which will easily leach away the runnings from small drips or leaks is preferable, next to solid rock. If located near a river, a wide margin of safety from flood should be allowed.

2d. If practicable, a location near a plentiful water supply should be chosen. Condensation of either high or low pressure engines is desirable in every way, and requires a large water supply.

3d. Nearness to the coal supply. If possible, locate near a navigable stream, so as to secure cheapness of handling coal and a plentiful supply of water. If not near navigable water, get a location on a railroad switch, and, if possible, near the water supply. If the two conditions cannot be fulfilled, you may make your choice between them, remembering that each additional handling of coal will cost about 10 cents per ton, and extra haul about 10 cents per 1,000 feet, and, on the other hand, that condensing your engines will probably save between 15 per cent. and 25 per cent. of your coal expense. The pressing necessity for locating near the lighting field has largely passed away with the introduction of long-distance systems of incandescent lighting.

Having determined on a location, the character of building to be erected must next be considered. The most important single condition essential to the success of the electric light business is continuous and reliable service to customers. The most disastrous calamity which can befall an electric lighting business, is the destruction of its central station. The first thing necessary to prevent such a calamity, is a building practically fireproof, and I believe a brick building best fulfills these conditions. Let the walls be bare, make all floors double planked and supported on iron beams, use no wood ceiling, however seductive it may be in improving the appearance of your station ; leave as few openings as possible through the floors ; have a nearly flat roof with fire walls projecting above, and the building will be as nearly fireproof as it can be, and at the same time fulfill the other essential conditions of insulation and a reasonable expenditure of capital. Before leaving the matter of fire protection, let me strongly advocate the use of some good automatic sprinkler except in the dynamo room, and especially in parts of the building unoccupied during portions of the day, a stand pipe connected with your spare pump with nozzles on each floor, a few lengths of mill hose, a cask or two set in convenient places and kept filled with water and a few fire pails being near are cheaply provided, and the improvement in insurance rates will soon pay for them. At Troy the reduction of rates has paid for the entire fire outfit in the saving in one year's premiums.

Before we design our station further, let me remark that the old adage that "cleanliness is next to godliness" would be a most wholesome motto for the electric light business. Dirt begets dirt, and with electrical apparatus it is by far the most fruitful source of short circuits, grounds, and consequently of buried armatures and disordered apparatus generally. Let us then so arrange our station that that most fruitful source of dirt, our boiler house, may give us as little trouble as possible. Putting the boilers in the cellar and the engines and dynamos on the floor above is probably the worst possible arrangement next to putting all in the same room, since every opening in the floor conveys a blast of hot air, laden with coal dust and ashes. The correct method is to separate boiler and engine rooms by a fire wall and make the only opening between through a room or passage through which a strong draft of air is always passing. This we effect at Troy by means of an air shaft 6 x 8 feet, which also serves as a wire tower and in which wash sinks, etc., are also constructed. The doors leading in both directions are kept shut by heavy springs, and when opened the strong draft carries all dust, smells, etc., up the chimney. This shaft is carried above the roof and the wires are carried out between the louvres of the blinds. One thing do not forget. Arrange a cellar or basement under your dynamo and engine room floor about six feet deep. You will find it infinitely convenient in connecting small pipes, etc., to the under side of the floor.

Make your dynamo room not less than ten feet high for the comfort of your men, and arrange the windows to open clear up to the ceiling, as that is where the hot air will go to escape. You may also put your windows six feet above the floor and you will save annoyance from spectators and your men will not have so much looking to do.

The boiler house should be light in construction, having an iron roof with some outside covering, such as asphalt, to prevent sweating in cold weather. The boiler fronts should of course face either on an open lot or a street to facilitate handling boilers, and for the same reason the front of the boiler house should be easily removable. The floor should be of concrete not less than a foot in thickness, made of the best Portland cement mixed about

1 part cement.
3 " sharp sand.
3 " stone broken to pass 1½ inch ring.

On this may be laid a floor of flags or arch brick laid on edge. No floor of cement or of ordinary brick will stand wear.

Going back to our main building, I will follow more particularly the line of work adopted at Troy. Our lot measures 50 by 130 feet, and the problem was to develop on that space a station of a maximum capacity of 500 horse power effective.

The lot was occupied by a mere shed covering two 80 horse power boilers located almost exactly in the middle of the lot ; one 150 horse power compound engine just beside the boiler, belted to 48 feet of jack shaft lying parallel with the length of lot, and two feet six above the floor, the dynamos lying each side of the shaft, the pull of the belts being nearly balanced.

The new station was laid out in a dynamo room 50 by 90, and boiler house 40 by 50 feet, arranged for a battery of four boilers 72 inches by 17 feet, stack 13 feet square at ground and 125 feet above the grates ; wire tower in corner between dynamo room and boiler house, projecting into the latter. As laid out, the engine stood in the new dynamo close beside the fire wall, separating engine and boiler rooms, and the boilers further out in the dynamo room. It was decided to build the unoccupied end of the dynamo room, put in engine power connected with the old boiler, shift the station, abandon the old engine temporarily, build the rest of the new station over the old; put in new boilers; then connect them and disconnect the old boilers; remove the old boilers, and finish the inside of the building. The company changed hands on May 23, 1885, and on September 1st the old station was shut down at midnight, and the dynamos shifted to the finished part of the new building, and at six the following evening the station was in full operation in its new quarters. The plant then comprised about 600 Weston incandescent lights and some 20 arc lights. The remainder of the work was merely a question of time, and the station was first operated on its new boilers on December 17, 1885. At the same time about 15 miles of pole lines were constructed, and some 30 miles of wire strung for the city contract of 130 lights.

The general construction of the Troy station is believed to cover the average conditions met with in central station construction, and is therefore particularized. In the arrangement of dynamos and engines we desire to attain the best economical results in the following items :

1st. Best average economy in coal.

2d. Best average economy in transmission of power to its work.

3d. Best economy of attendance.

4th. Best economy of oil waste, etc. Our customers required a day service, and we had to take this into account in our selection of engines for power, and in their arrangement.

These conditions were to be borne in mind

in the selection of our engines, and in addition the most important condition of reliability. Compound engines offered us the best coal economy, with maximum load, but had the disadvantage of poor economy with light loads Corliss engines would occupy too much room, and both required shafting and counters to speed up, and would have forced us to use the second floor for dynamos, with the attending disadvantages of extra help and upright belting. We finally decided on using the best type of high speed engines, and purchased three engines of 9x14 cylinder, each belted to a jack shaft 16 feet long, and each driving four 110-light incandescent dynamos, belted in pairs from opposite side of the shaft. The lengths were arranged to be coupled by friction clutches. This arrangement gave us a very uniform rate of coal economy, though not a very high one. The arrangement of belting made the shaft friction very small. The old compound was set to work on her proper duty of driving a fixed load of city lights.

The relative merits of compound, Corliss or high speed engines are well understood, and the circumstances must in every case decide the type of engine proper to be used.

Where the maximum of output is required from a small space high speed becomes a necessity. Where the load is very variable a number of smaller engines will give as good average coal economy as a single larger engine, with less chance of a complete failure. Where the load is heavy and constant, a pair of large engines will give the best economical results and at the same time cover the possibility of a complete breakdown. The new triple expansion engines which are rapidly replacing all others in ocean and lake steamers on account of their wonderful coal economy, will probably displace all others in the field.

Condensing high speed engines have not met with much favor, but we find at Troy that our "straight line" engines work quite as quietly under 28 inches vacuum as without, and that the coal economy is considerably improved; probably from 15 to 20 per cent. on the engines condensed. They have also the advantage of giving us much more power for cases of emergency.

As to boilers, I am strongly in favor of boilers of large size; ours measure 60"x17 feet, and are of Nashua "Indian head" steel, $\frac{7}{8}$ shell, $\frac{1}{4}$-inch head, and have 136 3-inch tubes. The dimensions of the tubes 3"x17 feet would be out of all proportions for ordinary drafts, but our stack 125 feet above the grates gives us ample draft and the small tubes a great evaporating surface, and consequently a better evaporation. I am afraid I shall be considered a little unsound of mind when I state that with these boilers we are able, and do, evaporate with a mixture of one part bituminous to two of yard pea and dust, nine pounds of water per pound of coal, and with ordinary buckwheat coal ten pounds of coal, feed water at 200 degrees. But such is the case, as I shall be happy to show any one visiting us. This is not pounds of combustible, but of coal. I have always found the ashes to cost just as much per ton as the fuel part of the coal, and therefore consider that they have no place in the relation of evaporation per dollar. We keep a daily and nightly record of our evaporation by a Worthington meter, which is on the boiler feed, and let me say that the bad reputation for veracity of meters in general will not apply to our meter, as repeated tests show a nearly constant error of 2 per cent. low. I may further say that our meter, though a Worthington, has no connection with the ELECTRICAL REVIEW. I merely state this to protect the meter from undue suspicion. (Laughter.)

For boiler feeds provide a reliable injector in addition to feed pump, which latter should always be used in connection with a good heater. An extra feed pump may be connected as a fire pump, and should be used regularly for some such service as washing out boilers, to ensure its being in good order.

Attention to surface and bottom flues is of course a daily duty.

As to fittings, use some one kind of valve; get a good kind and stick to it. Price should have no place in the first choice of valves. Get a good one with removable seats and disks and you will save a world of trouble and a deal—not an electric light deal—of money in a few years time. Let me remark that everything we have on bottom blow-offs has failed, except plain plug valves. The failure seems to come from scale, which will stick under the gates and seats, and bend them out of shape when closed. An extra large valve in the blow-off discharge is desirable in case of a failure of a blow-off valve.

In piping of all kinds discard elbows and use only Tees, you will frequently save taking down an entire line of pipe to make some connection by so-doing, and the T's are most convenient for examining and cleaning the pipes. You should also obtain all your fittings and pipe of one party to ensure good fits. Threading tools are seldom alike and a small variation will give endless trouble with leaks.

Cover all steam pipes, and remember in choosing a covering that it is not the material which you cover with, which makes the non-conductors, but the confined air spaces in the same. Get air spaces and get them so arranged that the air cannot circulate between hot and cold surfaces. Remember also that you can tell nothing by the feeling of the outside of a covering about its effectiveness. Sensations of heat and cold are intensified by the conducting capacity of the object touched. A piece of metal attached to a steam covering till hot will convince you of this. It can be no warmer than the covering, but it feels so.

In touching on the electrical apparatus I feel that I am treading on delicate ground, and I shall try and step accordingly. The principal elements of ordinary wear in dynamos are

1. Burned coils in the armature.
2. Wear of brushes.
3. Wear of commutator.
4. Wear of boxes or journals.

In regard to burned armatures I will say that judgment should be exercised in the choice of a system as to the liability of such an accident, and this being determined choose a machine whose armature is most readily repaired. Gramme and similar ring armatures are probably the most easily repaired. Siemen armatures and all armatures with lapped coils must go each to the factory for a good job.

As to brushes, the cheapest by far both in first cost and wear, are the single leaf, split brush. Multiple brushes are usually used in commutators with many segments, and there seems to be some relation between the number of segments and wear of brushes.

Commutators of many segments are less desirable than those of few. The segments can usually only be changed by putting on a new commutator and they seldom wear true. The segments on commutators of fewer bars are usually arranged to be easily removed and can then be turned up and replaced.

Plain babbitted boxes or bronze bushings are about on a par for convenience in renewal. Bronze has the advantage of not being liable to melt out and cause a shut down, and a little patience will almost always succeed in cooling them down. For belting probably nothing is better than double pasted leather belts if well made. For large belts a few rivets must be put in.

Arc lamps should be devoid of glycerine and not easily shaken out of adjustment. The lighter and smaller lamps are, the better for handling. Arrange all inside wiring of some first-class high insulation wire, especially on high tension circuits.

In the Keystone station in Philadelphia I first saw oil conducted to each machine oiler and cylinder cup in pipes. I heartily approve this system as saving both of oil and waste.

In conclusion I will suggest two rules to govern central station construction.

1. Expend every dollar which will return 10 per cent. on its investment in addition to maintaining itself, including, of course, interest, taxes and wear and tear.

2. After carefully investigating, estimating and planning out the capacity of your station, make a large guess as to what you require, and multiply by two.

REMARKS BY MR. C. J. H. WOODBURY, OF BOSTON.

After Mr. Powers had finished reading his paper, President Davis called upon Mr. C. J. H. Woodbury for remarks upon it. Beginning with an anecdote concerning the protest of an after dinner speaker, who had been similarly summoned to address a company without warning, and was told by the toastmaster that if he had notified persons in advance that they would talk for "hours and hours," he considered it of necessity a hint for a very few remarks. He commended the broad sense of the paper just read, as containing information worth the most careful consideration As to the question of the cost of insurance of electric lighting stations, which appeared excessive to those who knew the immunity which such buildings had, in regard to fires from electrical causes, yet the construction and location of these buildings were too often such that they would justly be considered quite as bad riks, if used for iron or wood working, or any other common industry not involving excessive hazard.

Electric lighting stations are too often placed in the center of a square surrounded by the rear of buildings, exposing risks of fire on all four sides of the station, in a manner where it would be difficult to apply fire apparatus.

Old buildings are frequently used for electric lighting stations, with such alterations as may be necessary to sustain the weight of the machinery; but, at best, such temporized structures are makeshifts, ill-suited to the purposes required of them Stores, school houses, soap works, and, in one instance, a lard oil factory, have been used for stations. The recent inventions in induction systems of distribution have removed the necessity of placing stations in the center of distribution, and, within reasonable limits, a station operated by steam engines can be economically placed in any portion of a city where water can be obtaind for condensing the steam.

In fact, the position near a water supply implies low land, free from grades, which add to the expense of coal haulage. Every element of convenience and safety, and room for extension, demand that a station should be isolated from other buildings.

For a large station a brick building with plank mill floors is preferable, but the conditions of convenience and safety can be met at lower cost in a wood building constructed with plank mill floors of 3 inch spruce plank laid upon Southern pine beams, 10 by 12 inches, and 8 feet on centers; let these beams rest on masonry piers dividing them into spans of about 10 feet. Set this floor 4 feet or more above the grade, so that it will be convenient to load and unload machinery from teams; and arrange so that the space under the floor shall be ventilated as a defense against dry rot.

This floor should be covered with inch hard wood flooring.

The sides of the station should be made of 3 inch plank grooved and spliced, and spiked to upright 11 foot timbers, 6 inches square, placed like the floor and roof timbers, 8 feet on centers. Secure the roof timbers to the uprights by hackmatack knees, and cover the flat roof with 3 inch plank.

Erect a monitor in the center of the roof to serve for ventilation, light, and for a wire tower.

Heat by $1\frac{1}{4}$ inch steam pipes, hung about 3 feet below the roof plank, and the pipes will be out of the way and warm the building, when any artificial heat is required, with less steam and more evenly than by the methods usually adopted.

It is preferable that the boiler house should be separated a few feet from the station, and built in a similar manner, except that the lower portion of the walls should be built of brick.

Such a station can be built for about 60 cents per square foot of floor, and will be as convenient and safe as any other method of construction.

If the growth of your station requires for dynamos, the room set apart on the first floor for supplies, repairs, and office, it will be an easy matter to raise the roof and insert a second story without interrupting the service of a single lamp.

The second story should be protected by automatic sprinklers connected to the fire pump, and also to the city water supply. There should be fire pails and hose from inside stand-pipe, with hydrant on each floor and on the roof.

There is opportunity for improvement in the care taken to keep stations in a clean and orderly manner.

It is economy to use good lubricants, and the oil dripping from the bearings can be filtered through charcoal and used over again.

By due attention to location, construction and care of electric lighting stations, you can, by reducing the fire hazard, virtually fix your own rates of insurance.

New Electric Measuring Instruments.

At a special meeting of the Glasgow Philosophical Society, held in the Physical Rooms of the University on Wednesday, the 20th April, Sir William Thomson described and showed a "double chain of electric measuring instruments," which contained various features of novelty. Sir William stated that he had been engaged in devising a chain of current measuring instruments, which should measure currents through the whole interval, from a millionth of a milliampere up to a thousand amperes, and a chain of voltmeters which should measure up to 40,000 volts. Six of the instruments shown were modifications of the old principle of the attracted coil, weighed in a balance. In the double acting volt balance there is a coil fixed to each end of the beam of the balance, so that in the neutral position it lies between two fixed coils, parallel and co-axial with it. The balance is adjusted to its zero position by a weight, movable along the beam by means of a screw, while the adjustment for sensitiveness is obtained by a vertical screw and weight. The balance is made by a sliding weight, which moves along a scale, forming part of the beam of the balance. When the zero position is nearly attained by this means, the reading is taken by means of a multiplying lever index, attached to the beam and scale. The requisite resistance coils for the potential instruments are attached to them, and their variation with the temperature determined, four different weights being provided with each instrument proper to the temperature 15°, 20°, 25°, 30°, C. respectively. In the current instruments, the resistance coils are, of course, omitted, the attracting coils being of thick copper. One most important novelty common to all the balance instruments, is the mode of suspension, by fine copper wires passing round cylindrical axes, giving the appearance between the axes of a miniature weaver's reed, which takes the place of the ordinary knife edge arrangement. This invention bids fair to oust the knife edge balance entirely, and not merely in electrical instruments, combining, as it does, the advantages of great stability, strength, and delicacy. Various other arrangements were shown in the case of the balance instruments. One had a scale pan for weights; a second, a series of cross bars at various distances from the middle point of the beam, on which weights were hung; while the weights in a third were hung in chains from the beam, each link being raised into position by a separate lever. Another new form of voltmeter was the marine instrument, which consisted essentially of a soft iron ellipsoid in the field of the coils, fixed to a vertical stretched platinoid torsion wire, an index pointer attached to the ellipsoid indicating the rotation of the ellipsoid when the current passes. This form, as its name indicates, is meant for marine use, the readings being unaffected by very considerable oscillations, such as it might experience on shipboard. An electrostatic voltmeter, which is a remote relative of the quadrant electrometer, was shown, for measuring high potentials. These instruments, together with the tangent galvanometer for small currents, will cover the entire interval, both of current and of potential measurements.

Will Enlarge Their Works.

The great demand for electrical apparatus is well illustrated by the growth and increase in number of electrical manufactories. The large new building of the Western Electric Company in Chicago has been found to be inadequate to meet the demands, and an addition, to cost $75,000, has been decided upon, and will at once be erected.

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The Connecticut bill looking to the regulation of telephone rates, requiring returns to be made to the Railroad Commissioner, was defeated in the Senate, after having passed the House. Regulation of telephone rentals by the various legislatures does not seem to have been successful this season.

The excellent remarks of President Davis, at the last meeting of the Electric Club, should receive earnest attention. This vigorous club, which has in less than a year become the foremost electrical organization in the country, largely due to the faithful work of the president, is well fitted to carry to a successful issue the project of building a club house in New York city, in which the educational, scientific and social features will all be recognized. The membership already justifies this move, and every month new applications are presented.

When electric motors were offered to the public some four years ago considerable confidence was placed in them; they have been improved in construction and efficiency, and by severe tests have been proved reliable. Still, with some, the elevator never sticks or the belt slips, but "something is the matter with the motor." The trucks, wheels, gearing, roadbed may be at fault, still it's always the motor that is said to be to blame. "We must wait till the electric motor is perfected," is given as an excuse why progress on some project is not made. The electric motor is perfected. It has less parts, is less liable to accident, is more easily repaired, runs at more even speed (if so desired) than any other form of prime mover. It develops power with less weight per horse power than any other. The time is not far distant when small steam, hot air and gas engines will be replaced, at least in cities and large towns, by electric motors.

Electric lighting is no longer an experiment. Stockholder-delighting dividends are not of the uncertain will-be. Electrical manufactories have been increased in capacity from 30 to 50 per cent. a year, and this season finds them unable to fill orders promptly. The activity manifested in electric lighting gives promise of a large volume of business in the summer and fall. Electric light securities are looked upon as desirable investments. Dividends are not always large, since improvements and extensions are paid for out of the earnings. Before long the capital employed in electric lighting will be larger than that invested in the manufacture of gas. The field open to the storage battery and secondary generators systems has yet been scarcely estimated. Transmission of power for manufacturing, operation of street and elevated railways, will, in the near future, require as much capital as is now invested in the entire railway system of the country.

SELLING ELECTRIC LIGHT IS SELLING POWER.

It takes power to operate an electric light plant. The current supplied to lamps and transformed by them partly into light is produced at the expense of the coal pile, and in well-managed plants an increase in the number of lights requires a corresponding increase in the fuel consumed. If the engines of a station were belted to a line of shafting of a mill next door, it would be easy to realize that power was really being sold. When the power is turned into current by the dynamos the case is hardly different. To make a profit in either case, the product, power, which is sold must be produced cheaply. Steam engines of high economy, the most approved boiler settings, feed pumps, injectors, damper regulators, all assist in reducing the cost of producing power. Coal costing $5 per ton has no greater steaming power than a mixture of cheaper grades costing $2 per ton. The difference is saved. A comparison of the profits of electric light companies shows that in many instances to cheap fuel, intelligently employed, is due much of the success of those corporations that are earning large dividends.

IMPROVEMENTS IN INCANDESCENT LAMPS.

The life of an incandescent lamp is often 2,000 hours, and sometimes far exceeds this, there being lamps still in use burning 5,000 or more hours. Such a large percentage have long life, fair efficiency, and little evidence of blackening, that the question has been asked again and again why all do not give such good results.

One or more of the following imperfections in the manufacture shorten the life:

1. Imperfect exhaustion.
2. Bad contact with the platinum.
3. Inequalities in the carbon.
4. Unsuitable baking of the carbon.

The first two difficulties were overcome some years ago, and much study has been directed to improvements in the carbon itself. There is now a good prospect that the results of study and experiment will lead to the manufacture of lamps of desirable life and high efficiency, and that, instead of eight or nine 16-candle power lamps to the mechanical horse power, fourteen to sixteen may be obtained. Whatever improvements in dynamos, converters, distributors and means of storing and supplying electricity may be made, the reliability, lessened cost for repairs and automatic regulation offer a larger field for improvements than the efficiency, which is now about 90 per cent. Any improvement in the efficiency of the lamps increases the capacity of present plants, and at no expense. Central stations earning 6 to 10 per cent., and competing with gas for illuminating purposes, could take complete possession of that field, and earn 30 to 40 per cent. on the capital stock.

A BUILDING FOR THE ELECTRIC CLUB.

At a recent meeting of the Electric Club the need of a building suited to its purposes was considered, and the beginning was made of measures relative to the matter. There is nothing in this feeling peculiar to the electrical organizations, for every technical society in the city has proved the same desirability of a local habitation by logic sound beyond peradventure of cavil. These societies have gone over the same ground and unanimously accepted reports of committees, but as to further action they have strictly followed the precedent of the legislation of the mice in resolving that the cat must wear a bell.

There are about one hundred and nine well established societies in New York City devoted to engineering, scientific and electrical purposes, but none of these, as far as we have been able to learn, own any building, except the American Society of Civil Engineers, who own a modest dwelling house badly arranged and well mortgaged.

The proposition has been more than once offered, would not a building especially constructed for these societies prove a sound and remunerative investment for a capitalist? Its location, beyond a reasonable convenience to elevated railroads and lines of horse cars, need not be on expensive land; it would be permanent in its nature, not subject to mutations of trade or fickleness of fashion, which has been such a disturbing element in real estate values in this city; and the amount of the capital invested in the land would be less than in any building of equal value, placed in a location where business seeks for the most favorable positions.

Such a building, as one might sketch in outline, would be used on the first floor for stores devoted to the sale of books, scientific and engineering instruments, and also a first class caterer with restaurant if the locality be favorable.

Above, one large hall and several smaller ones with screens for stereopticon illustrations, and gas and water for scientific purposes, which could be used for meetings of these societies, and also for general lectures and concerts, as might be required.

A portion of the building should be devoted to suites of rooms for permanent use by secretaries and meetings of boards of management of such societies.

The libraries owned by the scientific societies in New York are of great value to specialists, as much of every collection is practically unique, and could not be replaced in case of fire; yet they are, without exception, stored in combustible buildings, exposed to great hazard from both flame and water in case of fire, and are, as a general thing, not well indexed or surrounded by facilities for use.

Therefore the edifice must have a reasonably fire-proof library building, containing these collections each by itself, but supervised under one administration of librarian, with one system of card catalogue, and open to the use for consultation by any member of the societies occupying the building.

The usefulness of the libraries would be enlarged both as to facilities of work, but it would also give opportunity to increase the number of titles by disposal of duplicates and avoidance of their purchase in the future.

The caterer in the first story would not be forgotten, "for high science and low feed" is an error which is contradicted at every meeting of these societies. In fact some of the most enjoyable of the social occasions connected with these societies are also the most instructive, for in freedom and without conventional restraint of a formal paper read before an audience, the most valuable and important opinions are given in conversation arising at dinner or lunch.

On one occasion a prominent citizen of New York entertained at lunch one of the engineering societies during their annual meeting, and when arranging the preliminaries with the caterer, the latter asked whether the gentlemen were scholars or practical men. "What is that to you, beyond that 125 are expected?" was the reply. The caterer said that one class were hungry and the other thirsty.

We forget the appetite assigned to each, but from recollections of the occasion *quorum pars fui*, we expect that Monsieur Chef must have been told that all of them belonged to both classes.

But we trust that the present efforts to raise funds for purchase of real estate by the Electric Club will result in success; for the consummation of any plan for the erection of a union society building must necessarily be well in the future, and real estate in New York city is the best investment that any society can make, and such property can surely be sold to advantage should the first plan be carried to completion.

But the ownership of property conduces to the solidarity of any organization, and should be made an especial effort on the part of those engaged in the furtherance of applied science.

BOOK REVIEW.

Lessons in Elementary Practical Physics. Vol II.: Electricity and Magnetism, by Balfour Stewart, Professor of Physics, Owens College, and W. W. Haldane Gee. 497 pp., 123 illustrations and figures. Macmillan & Co., New York, 1887.

This volume is a valuable contribution to the very limited number of treatises on practical instruction in electricity and magnetism. It is designed to serve as a hand-book in laboratory courses. The inventive and constructive faculties of the student receive due attention. The greater part of the apparatus is simple, yet second to none in accuracy, and is expected to be constructed in the laboratory in part by the pupil himself. The first three chapters treat of the whole subject in an elementary way. The fourth of Measurement of Resistances; V., Tangent Galvanometer; VI., Use of Magnetometer and Dip Circle; VII., Electro-Magnetism and Electro-Magnetic Induction; VIII. and IX., Condenser and Electrometer and Applications. The appendix treats of the principles of Wheatstone's Net, Force, Potential, Lines of Force, Electrical Units, Induction, Determination of E.M.F., Practical Details and Tables.

It is not a compilation of old works, but the outcome of many years of practical teaching in the laboratory. The difficulties which beset the beginner have been explained. The language is simple, and the only mathematics required is an elementary knowledge of algebra. Those who are looking for a book with which to begin the study alone should obtain this, construct the apparatus and perform the experiments. The cuts are new, in many cases made from photographs of the apparatus employed. The book is remarkably free from errors. On page 71 silver is not mentioned among the impurities in commercial copper, page 75 the cosine galvanometer invented by Prof. John Trowbridge of Harvard University is, as is usual in foreign books, called the "Obach." All desirable methods of measurement of E.M.F. resistance, current, capacity, self-induction, mutual induction, etc., are given. The authors deserve great credit for this work, which should be in the hands of every electrician and student of electricity.

OUR CHICAGO LETTER.

(From a Special Correspondent of the ELECTRICAL REVIEW.)

Mr. J. H. Reid, manager of the Mather Electric Company, western department, has more headquarters than he knows precisely what to do with. For instance, a certain portion of his correspondence is delivered at the American Electrical Manufacturing Company's place of business, where he used to be; another regular correspondent sends mail for him to 118 LaSalle; and his real business home, where he can be found—all advertisements to the contrary notwithstanding—is 38 and 40 LaSalle street. Reid says he trusts the first of May muddle is nearly over, for it has been a sore trial to him

The institution for the feeble-minded youth of Nebraska, at Beatrice, is to be lighted by the Mather-Perkins system. Mr. Reid scooped the contract, which calls for one 150 light dynamo, and something over 200 incandescent lamps, so distributed that at no time will there be a full load on the generator.

Three young scientists, recent graduates of Cornell university, have organized the Western Engineering Company at Lincoln, Nebraska. The gentlemen composing the firm are all competent to use the mysterious initials so often met now-a-days, E. & M. E., and to attack an electrical or mechanical problem successfully. The manager of the company is Mr. J. G. White, late professor in the University of Nebraska, at Lincoln.

The tearing up of LaSalle, Monroe, Dearborn, etc., for the new cable road, has brought out any quantity of inquiry about the progress of underground matters here. Professor Barrett has been repeatedly interviewed on the subject. In one of the latest of these talks the Professor said: "We have stripped down everything between Van Buren and the river except Washington street, a little on Dearborn and a piece on Michigan avenue. I expect to have everything out of the way as far south as Twelfth street this year, though I don't know how much money I will have. The telephone company is clearing its wires on West Madison street, between Western avenue and the river, and we will probably get ours down too, this year, and we hope to remove those on the upper part of South Canal street. This will clear up all the heavy wires on the south and west sides. We may get them out of North Clark and part of Wells on the north side, before the money gives out.

"This is the only city in the United States, notwithstanding a great many have passed underground ordinances, where a single pole has been pulled out in accordance with these laws. Possibly the other cities have more pliable councils; or, I guess, by paying a little tax for them, or by going into the courts they have delayed the matter; or their corporate bodies may be a little different from what they are in Chicago; or may be there are some atmospheric reasons why the thing cannot be done anywhere else but in Chicago. I do not know. The fact, however, stands that Chicago is the only city in the United States that has done anything practical in the way of burying the wires."

There is a serious unpleasantness between the Baltimore and Ohio Telegraph Company, and two of its former customers, John T. Lester & Co., and Schwartz & Dupee; the company having sued to recover damages for alleged breach of contract, on account of leased wires between Chicago and New York, which the defendants, as is claimed by the plaintiff, abandoned because of better rates offered by a rival company.

A steam yacht is being constructed in Chicago by a west side firm of iron and steel workers. The vessel will have a length on deck of 90 feet, and a breadth of beam of 14 feet. Arrangements are being completed for running a large variety of electrical bells, calls, etc., and a full incandescent outfit will be placed on board before she enters upon her summer cruises.

Messrs. Humbird & Gorton, the Western and Southern representatives of the Edison Company here, report the following accessions to the Edison ranks. The company at Columbus, O., which has been examining various systems of incandescent work formally adopted the Edison on the 19th. Work is to be commenced at once on a central plant of 10,000 lights capacity, the wires to be all placed underground; and at Kansas City, Mo., a local Edison Company has just been formed, which will soon commence business with 5,000 lights.

The Chicago Edison Company now has the following officers, elected at the last meeting of the directors a few days since: A. F. Seeberger, president; J. W. Doane, vice-president; F. S. Gorton, secretary and treasurer. The company by its representatives is doing a large amount of skirmishing with a view to establishing central incandescent stations in Chicago, but in the words of the old song:

"Nobody knows where the skirmish lines goes,
Nobody knows but the gin'ral."

The Excelsior Company, heretofore represented by Mr. Chas. J. Reilly, will hereafter be represented by Mr. W. H. Cole, who is well known here by the electric light people. The office of the company will remain at 137 Madison, where Mr. Cole will be pleased to see his old friends. Mr. Reilly leaves Chicago to accept a similar position at St. Louis, Mo. whither Charley carries the best wishes and hopes of the entire fraternity.

A new central plant has just been inaugurated in a portion of the city where the electric light has hitherto been unknown. On Wabash avenue, between Fourteenth and Fifteenth streets, the Fort Wayne Jenny people have placed a plant of thirty lights and expect to increase this, until the good people of the neighborhood will be as happy as light can make the human race. The illumination now extends over some three blocks, and the neighbors are screaming for more with that unsatisfied howl which always darkens the air in the neighborhood of a new plant.

CHICAGO, May 23, 1887.

OUR BOSTON LETTER.

(From a special correspondent of the ELECTRICAL REVIEW.)

The Sun Electric Company, of Woburn, Mass., are busy filling orders for their alternating system, and have just completed a 400-light plant for the Brush Electric Lighting Co., of New York city. The plant operated by the Boston Electric Lighting Co. is giving excellent satisfaction, the lamps showing longer life than when used on direct current systems.

The New England Telegraph and Telephone Company are rapidly extending their underground system in Tremont street. About 250 feet is laid each day; a manhole is set at that distance, and the cables drawn through, the ends of the separate wires being soldered in the manhole. These are built of brick, 4½ by 3 feet. The top is partly covered by two flagstone caps, leaving an opening about two feet square. About 1,500 brick are required for each manhole. The best cement is used, and when an iron cap is placed in position and the joints sealed with pitch the whole is watertight. The New England Company is making an earnest effort to solve the question of underground wires, and it spared no expense to establish a reliable system. The conduit is put down to stay down. It is made in 12 feet sections, the form being that of a square box 13½ inches on a side, made of 2½ inch plank; partitions 1 inch thick form 9 square compartments 2¾ inches square, large enough to hold a 2½ inch cable. At the ends of the sections the edges of the compartments are trimmed so that in drawing in and out the cables there may be no sticking. The ends of sections are placed close together, and three thicknesses of paper and pitch put on. The wood of which the sections are made is thoroughly saturated with pitch during the process of manufacture. The conduit has a capacity for 1,800 wires. A reporter visited Tremont street near the Metropolitan stables. In the distance gangs of men were excavating; a little nearer others were hoisting with a light derrick the sections and arranging them in place; farther down the nailing of portions of the conduit with galvanized nails was going on; and still farther to the rear was a gang of men making the joints between the sections; closely following another gang was refilling and paving. Great care was exercised in ramming the earth, so that there could be no shifting of the conduit from settling of the ground.

The Globe Theater is drawing large crowds with Ruddygore, as presented by a Yankee company, the lighting being done by incandescent lamps. Prominently advertised is "No gas, no heat; illuminated by the Edison incandescent light."

The Old Colony Railroad early in the season decided to test the practicability of storage batteries for train lighting, and ordered an experimental plant of the Electrical Accumulator Company. A month ago, car 190, used for suburban service, was fitted with 24 7 B cells, 12 being placed in a compartment on each side of the car, below the floor timbers.

The cells are of okonite, and 45 volt lamps, furnished by the Sun Electric Company, are used, requiring one ampere per lamp. There are 12 lamps inside the cars, six on a side, on the lower edge of monitor roof, one in the toilet room, and one on each platform. Each lamp may be cut out separately at the socket, one whole side, or every other lamp, three at a time, by switches at the regulating box. This is placed over the closet at the end of the car. One ohm of German silver wire in four spirals is connected to an asbestos base switch, and the brilliancy of the lamps varied as desired. The depot men, when the train is made up, open this box and light the lamps, leaving them at half brilliancy. A few minutes before the train starts the conductor brings them up to full candle-power, using a part or all of the lamps, according to the number of passengers. The light is required at present from 8 P M. till midnight. The expense for charging is at present one-half cent per hour per lamp, or 75 cents a day for the car. At 10.45 A. M., at the Stanhope street station of the Boston Electric Lighting Co, the current is switched on to a loop running to the Old Colony depot, and is switched off at 4.30, a current of 15 amperes being maintained in the meantime. Connection is made with the battery by plugs attached to flexible cords of copper. The plugs and sockets are so varied in size that it is impossible to make a wrong connection. Mr. D. H. Washburn, the electrician of the New England department of the Accumulator Company, explained to the REVIEW reporter that the lamps could be used and their candle power regulated as well during charging as before. A test was made, and notwithstanding the variations of every arc circuit, the lamps were absolutely steady. The expense for batteries, etc., per car is $375. The car (No. 139) is now the middle of a three-car train. The front and rear platforms of the train are closed in, and all passengers enter and leave the trains by the platforms adjoining the middle car, or the platforms of that car. These being brilliantly illuminated by the incandescent lamps, passengers enter and leave the cars more rapidly, saving at least a quarter of a minute at every stop. It has been found that on the steady current of a storage battery lamps last much longer than on dynamo current, and that the saving due to increased life more than pays the interest on the capital invested. The liquid is kept within three inches of the tops of the cells, and there is no slopping.

The insulation of "Underwriters" wire is not waterproof, and by manufacturers, electricians, and insurance inspectors has never been considered as such. The name, to the uninitiated, conveyed the idea of guaranteed insulation. Under sinks, in closets, near water pipes, there is danger that wire become soaking wet, and no more than 50 volts, with wires six inches apart, is required to form an arc and start a fire. The possibility of contact with metal when gas pipes are put in, repaired or changed is great.

The action of the Boston Fire Underwriters Union in not accepting Underwriters wire for use in concealed places has been made after careful consideration. No objection is made to Underwriters wire when not concealed. The Boston Electric Light Company has for some time practically followed the course prescribed by the Underwriters Union. The Edison (central station) and Edison Isolated have employed waterproof wire for concealed work. The rule will therefore apply particularly to inexperienced wirers.

BOSTON, May 24.

GENERAL BUSINESS NOTES.

—— Five hundred incandescent lamps of the United States Electric Light Company have been contracted for by the Paterson Mills, Chester, Pa.

—— The Goodyear Rubber Glove Manufacturing Company, of Naugatuck, Me., has contracted for 760 incandescent lamps of the United States Electric Lighting Company's system.

——The Electrical Accumulator Company of this city, has contracted for lighting the New York and Chicago limited express on the Pennsylvania road. There will be six cars in all, and a total of about 140 lights will be required.

——The Mutual Electric Company, Brooklyn, N. Y., is in receipt of a great many inquiries concerning their new automatic time cut-out for electric circuits, mention of which was made in the REVIEW a few weeks ago. Wherever tried the time cut-out has given complete satisfaction.

—— The Julien Electric Company, 120 Broadway, has just issued an attractive catalogue, in which many interesting points relating to storage batteries appear, which will be sent to all seekers after information concerning this now rapidly developing branch of electric work.

——The demand for their insulated pliers is reported by the electrical house of J. H. Bunnell & Co. to be rapidly increasing, and they are arranging to manufacture them on a large scale. The best of rubber insulation is provided, and in consideration of the protection they give, the pliers are furnished at so slight an advance on the uncovered ones, that the call for them is easily understood.

—— The India Rubber and Gutta-Percha Insulating Company, W. M. Habirshaw, general manager, have sent out from 159 Front street, this city, a neatly printed card on which appear in bold relief views of their India rubber covered cables, with figures accompanying each size, giving weight of copper, insulation resistance, resistance of copper, price per foot, etc. These cards will be in demand.

——Prof. Thomas Edison, who has recently purchased a large tract of land on Lakeside avenue, Orange, N. J., has had preliminary plans drawn for what it is believed will be the largest and most complete laboratory in the country. The new building is to be of brick, three stories high, with a ground plan 60x250. The lower floor will contain a library of several thousand volumes on scientific subjects. It will be handsomely furnished in hard woods. In the large room, 60x200, will be placed the boilers, engine and heavy machinery. The two upper floors will be divided into smaller rooms for experimental purposes.

Telephonic News

*** The decision of the Supreme Court in the telephone cases is looked for this week.

*** The headquarters of the East Tennessee Telephone Co. is now located at Bowling Green, Ky. Mr. O. F. Noel, the president of the Cumberland Telephone Company, is also president of the East Tennessee Company, with headquarters at Nashville. Mr. Noel is one of the most successful managers of telephone properties in the South. Mr. J. N. Caldwell, of Nashville, is secretary under the new management. We are very glad to learn that Auditor Dutton decides to remain in New York.

*** The annual meeting of the stockholders of the Great Southern Telephone and Telegraph Company was held at Henderson, Ky., on the 10th. The annual report of the president was read, accepted and ordered printed. Vacancies by expiration in the board were filled, and at the meeting of the board of directors the following officers were elected: President, M. G. Kellogg; Vice-President, W. H. Bofinger; Secretary and Treasurer, Paul J. Maus; General Manager, J. J. Fowler; Executive Committee, M. G. Kellogg, W. H. Bofinger, J. J. Fowler.

*** It is claimed by Mr. W. H. Dorsey, of the firm of Dorsey, Paine & Co., of Chattanooga, Tenn., that he has constructed an improved instrument for the transmission of telegraphic messages. The new feature of this instrument is that any number of wires may be attached to one instrument, and one about three feet in length and about ten inches in height by about six inches in width is capable of receiving fifty wires, and which may be operated by one man without leaving his chair. One key is all that is required by this instrument, and the relay is perfected by means of a key that is inserted into a hole in the box to which the particular wire is connected. This instrument is also fitted with a double attachment, so that when the operator has received his message the superintendent's room can then receive the same message. This duplicate attachment obviates the placing in the superintendent's room another set of wires.

*** There is an old story of two men who, being desirous of patenting a certain article which would prove very valuable, took the same train for Washington, and mounted the steps of the Patent Office together; but in the jam at the door one was given the advantage, and made the first application. The story may have been the outcome of some one's fancy; but the following, which is in every sense more exciting, and true in every particular, occurred in this city yesterday.

Mr. Wilson, member of the tea company doing business on Main street, Kansas City, Mo., for the past few weeks has been negotiating in a $650,000 deal in Omaha. He had supposed his opponent had closed the deal. The other evening, however, in conversation with the opponent, who had just come in from the East, the property became the subject of discussion.

"I own that you made a good investment," said Wilson.

"The h—l I did. Didn't you close that deal?"

A vigorous buttonholing followed; arms were raised high in the air, and all of a sudden both men were seen to start down Main street, running wildly. One made for the Office of the Western Union, and the other for the Pacific Mutual. Both wired to a place four blocks from the telegraph office at Omaha, and both waited expectingly for an answer. In exactly eight minutes an answer came back to Mr. Wilson, who had wired over the Pacific Mutual: "The deal closed; all O. K."

With a smiling face he crossed over the street, and tapping his friend on the shoulder, showed him the answer. That was enough; the Pacific Mutual had greased wires, and the words flew like lightning. The extraordinary time in which the message was sent and answer received certainly reflects credit on Manager Clohesey, and on the company, as well, of which Mr. Geo. M. Meyers is the very capable general manager.

Telephony in Scotland.

A very useful instrument belonging to the National Telephone Company is the intermediate switch designed by Mr. J. D. Miller, their resident manager for the Dundee district. This instrument was devised with the object of securing a thoroughly trustworthy switch, the contacts of which should be rubbing and self-cleaning. This object has been attained by making the contacts of

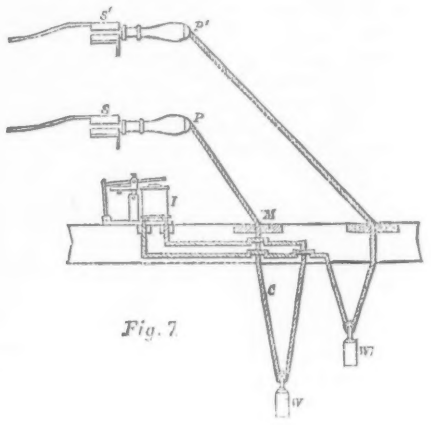


Fig. 7.

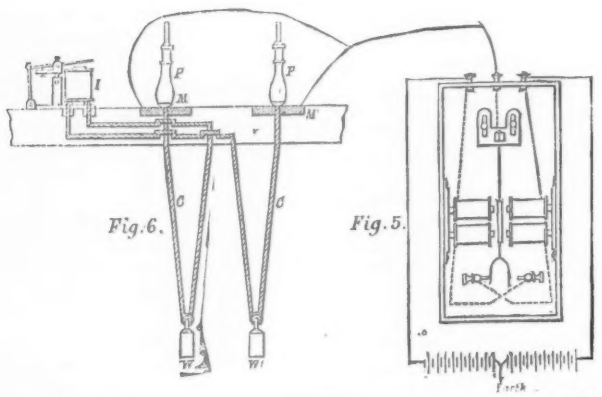


Fig. 6.

Fig. 5.

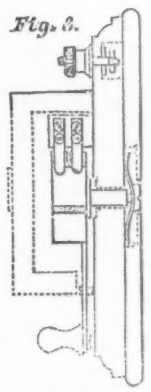


Fig. 3.

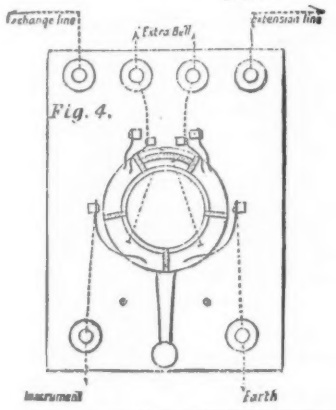


Fig. 4.

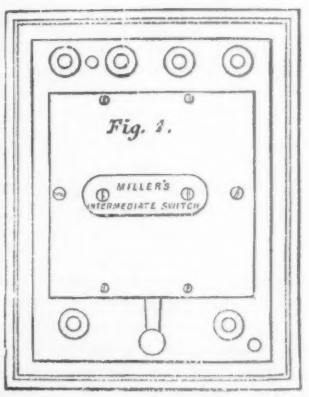


Fig. 1.

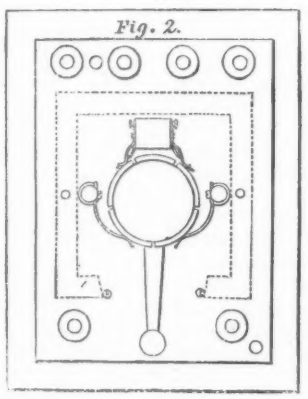


Fig. 2.

MILLER'S INTERMEDIATE SWITCH.

German silver springs, which press firmly on curved strips of brass, supported on a cylinder of ebonite. By referring to Figs. 1 to 4, the reader will find the details of the switch very clearly and fully represented. In practice the instrument has been found to be most effective in surmounting the various annoying faults to which the common forms of direct-contact switches are liable; and it has been adopted by several other telephone companies. The switch in question is intended to operate midway in an exchange line, and it enables the middle station to communicate to the left-hand or right-hand stations singly, or to let them converse with each other, as may be required, while always preserving an audible signal in the shape of a bell at the middle station.

At Fig. 5 there is represented a simple and effective pole-changer, which has been designed by Messrs. Brown and Jamieson, of the National Telephone Company's Dundee staff. Its purpose is to supply an alternating current to the switchboard, by means of which the operator can ring the subscribers' polarized call-bells. The utility of this instrument will be better understood by considering it in connection with Figs. 6 and 7, which represent a very effective device, which Mr. A. R. Bennett brought into use for enabling the operator to ring the subscribers' bells without losing time in turning switches, pressing keys, or inserting special ringing plugs. At M and M^1 (Figs. 6 and 7) there are represented two nickel-plated brass strips, which extend the whole length of the switch-table. Upon them all the pairs of switch-plugs in use at that table (generally fifteen to twenty in number) rest when not in use; and they are kept in position by the weights W W^1 working on the flexible conductors C C^1. The bases of these plugs—two of which are shown at P P^1—are made of nickeled brass, and are in metallic connection with the points of the plugs. The strips M M^1 are in permanent connection with the delivery terminal of the pole changer, so that the points of the plugs, as they rest on the strips, constitute one pole of the battery. When it is required to call a subscriber, the operator lifts one of a pair of plugs and inserts it into the proper spring-jack—say, P into S, in Fig. 7. An alternating current is immediately sent over the line, and rings the subscriber's polarized bell, since the remaining plug P^1 remains resting on its strip, and the current flows from the pole-changer through the strip M^1, base of plug P^1, through the flexible switch-cord C C^1, the ring-off indicator I, to the spring-jack S, and so to "earth" through the subscriber's line and bell. After the lapse of two seconds, the operator lifts the second plug P^1, and inserts it into the spring-jack S^1 of the subscriber initiating the communication, thereby connecting him to the person whom he wants. On hearing his bell rung, the subscriber who is called goes to his instrument, and, without ringing back, lifts his telephone off its hook and speaks. At the conclusion of the conversation one or both of the parties turn their magnetos, an action which drops the shutter of the ring-off indicator I, and signals the operator to disconnect. This system of ringing is in use in Edinburgh, Inverness, Dunfermline, Stirling, Galashiels, Selkirk and other towns, and conduces materially to rapidity of switching. Instead of a pole-changer, an alternating current magneto machine, driven by water or other power, may be connected to the strips M M^1.

Submarine Cables.

A statesman of a bygone period, whose speeches hold a classic position in political literature—we refer to Edmund Burke—tells us that "circumstances are infinite, are infinitely combined, are variable and transient; he who does not take them into consideration is not erroneous, but stark mad—*dat operam ut cum ratione insaniat*—he is metaphysically mad." A little further on in the same speech he says, "Crude, unconnected truths are in the world of practice what falsehoods are in theory." It is just these crude, unconnected truths that we find it difficult to combat. One cannot deny a truth, and it is difficult to deny the relevancy of a truth. Thus we cannot deny the desirability of the reduction of the cost of telegrams, nor can we deny the desirability of further cable connections. What we do deny is that the destructive suggestions which have been made to compass these ends are good suggestions, and such as should commend themselves to men of business.

We contend that cable lines are somewhat analogous to railway lines, and consist necessarily of two great divisions, the trunk lines and the branch or feeding lines. When the commercial prosperity of a cable system is considered, the feeding branches are almost as important as the trunk lines. Glasgow, no doubt, is a very large and a very important town; but we doubt if it would pay to construct a railway with termini at London and Glasgow, but with no intermediate stations. The same applies, perhaps, still more forcibly to smaller and more distant places like Aberdeen and Inverness. Thus in railway management the main lines are taken, so as to keep the business of as many great centers of industries as possible, besides having branch lines leading to minor centers. The development of the cable system of the world has similarly followed this course, and whenever possible the traffic of the main lines is augmented by means of branch lines or feeders. We should hesitate, then, from a commercial standpoint, to support any scheme that pursued an opposite policy. We need not insist further upon this point, but take it for granted that our contention will not be disputed.

A few words as to alternative routes. At the present moment there exist alternative, and not only duplicate but often triplicate and multiplex routes to many a foreign trade center, and also to many a colony. In the natural order of things it seems most probable for these alternative routes to increase; for example, the West African cable will sooner or later be continued from St. Paul de Loando southward, so that another route to the Cape, is obtained, and not only to the Cape but to India, China, Australia, and New Zealand. Again, one need not assume the mantle of prophecy to foresee that land lines or cable lines will run northward on the west coast of America, till at length a short cable junction will connect that part of America with the Asiatic continent, giving still another alternative link to the telegraphing public. These extensions await the development of trade in the regions indicated, otherwise investors have no inducement to embark their money in cables to places where no trade exists and where none is likely to exist. If alternative routes are required for imperial purposes they must be made at the expense of the taxpayer, and the links should be made in those directions where the expenses, if not the interest on the capital, would probably be obtained from trade development.

We shall now touch briefly upon the much-discussed question of traffic rates. This question must, like all the rest, be argued from a business point of view; and in the first instance, when a cable line is laid, the management has to estimate the probable business and make its tariff accordingly. Subsequently the tariffs can be raised or lowered, as experience dictates. Usually, however, there is a cry to lower the rates, and great pressure is put upon the management to do so. There is seldom any desire on the part of the cable companies to overlook just claims; but the first duty of the management is certainly to obtain a fair return to the shareholders whose capital is invested in the undertaking. If it can be shown that the return obtained is out of all proportion to the risk, then, no doubt, the tariffs must be reduced. If, on the contrary, the return is fairly satisfactory, the shareholders cannot be expected to give what they have not to give. In other words, if the reduction of tariff leads to a diminished return, then the loss is wholly on the part of the shareholders and not upon the people who benefit most by the work. It is better to discuss this question in a specific manner, and we confidently appeal to our readers to support our conclusions from such a case as the following: Given a cable system, paying its shareholders, say five per cent., with a given tariff, and the traffic with such a tariff. Circumstances induce the management to lower the tariff, and they expect to recoup the loss thereby certain by an increase in the business. Time—an important factor in the discussion of this problem—is always required to enable the extra business to develop and recoup the loss, and during this time the returns of the system are less than under the previous conditions. The shareholders, and the shareholders only, are the losers. Why are they to lose in this way? Other business men are seldom placed in such a position as to be more or less in the power of prime ministers and principalities, and would object to bear such loss.

As we read the present state of affairs the cable companies do not relish the pressure brought to bear upon them to the de riment of their shareholders, and suggestions have been made to the various authorities interested to this effect. The authorities may deem the matter of sufficient importance to lay a burden upon the taxpayers of the nation, or the colonies generally, by the payment of a subsidy guaranteeing a given interest upon the capital embarked in the cable enterprise. If this is done the cable companies have no objection to let the various authorities make their own tariffs. In time, no doubt, a great reduction of tariffs may develop trade sufficiently to pay the required interest and relieve the taxpayer. Meanwhile the tax payer bears the loss. It seems to us that this plan is perfectly just. The shareholder evidently is not called upon to bear the loss; he is not a philanthropist, but a man investing his money to obtain a fair return, while, on the other hand, if the country or colony, as a whole, benefits by cable communication, the country or colony, as a whole, should pay for the benefit received. — *London Electrician.*

W. T. Mottram has resigned his position as electrician of the Wilmington City Electric Light Company, and accepted the superintendency of the Edison Company at New Orleans.

A New Telephone Call Register.

Mr. A. F. Adams, of Little Rock, Ark., has invented and patented what is, we think, a practical telephone call register, which we illustrate and describe in this issue. It contains, as will be seen from the drawings, a set of dials operated by the cylinder *B*, when turned by the key; a set of electro-magnets *H*, looped in circuit with those of the call bell; and a circuit controlling device, controlling the generator of the call bell, with button *J* for opening and closing the shunt circuit around the same. In operation the subscriber places his key in the hole k^1, and gives a half turn to the right; this revolves the cylinder *B*, and makes connection across c^1 c^2 *via* g—g^1—4, etc., and upon pressing *J* and turning the crank of bell a call is sent. When *J* is pressed, the spring *j* not only opens the normal shunt around the generator, but also closes a short one around the magnets *H*, cutting them out, preventing any shortening of the signals; but upon releasing same they are again returned to circuit, and any current from another station actuating their armature h^1 will cause the arm h^2 to lift spring g^1, causing a break in the generator circuit between springs *g* and g^1, and as a stop on cylinder *B* is caught by the lever *h*, *B* must be turned completely around before another call can be sent, and in doing this the unit dial is actuated one point, thus registering the call.

It will be seen that calls coming in are not interfered with in any way. But it is impossible to call without having and using the key; this prevents any unauthorized use. The key, when placed in the keyhole, cannot be turned backward, but must be turned half around before a call can be sent; and the key, after being turned to the ringing position, cannot be taken out by turning backward, but must be turned completely around in a forward direction before calling again and being able to remove it.

Means are provided, however, by which the key may be turned backward from the ringing position and removed without registering, when from any cause a connection cannot be given by the central office sending a current through coils *H* and lifting lever arm *h* far enough to miss the slot or catch b^3 in *B*, thus allowing *B* to be returned to its normal position, and at same time setting springs *g* and g^1.

The Edison machine works, at Schenectady, N. Y., are manufacturing an excellent quality of covered wire, and have sent out a number of handsome sample cards.

A Stupendous Electric Scheme.

Dynamoproktos, the inventor, was unfolding his scheme before a syndicate of capitalists, consisting of two men. He took a single junction thermopile of copper and iron and showed by a galvanometer attached that a current of electricity was generated when one junction was heated and the other cooled. "My plan is entirely new and original. (They always say that). I propose to erect lines of enormous wires running from the South temperate zone to the Arctic circle. Each circuit consists of an out and a return wire of copper, the terminal junctions being of a special alloy of antimony and of bismuth. The lines once built, varying currents, depending upon the difference of temperature between the bismuth-antimony terminals, are generated, the energy coming from the heat of the sun. Many times the amount of power now used in the entire world may be obtained. There is an additional advantage in that the climate of the torrid zones can be made cooler and the climate of the Arctic regions milder."

"There's one hitch in your plan," said Pffaankfe. "The magnetic poles of the earth would be displaced to amounts varying with the current passing over your lines."

This new, practical system of generating electricity without expenditure of energy on the part of any earthly being is given freely to the world, although the author from experience finds that the world is slow to take up inventions under such circumstances, and that it is far easier to patent the same than to make it public property.

Officers Elected.

At the annual meeting of the American Institute of Electrical Engineers, held last week, new officers were elected as follows President, Mr. T. C. Martin; vice-presidents F. L Pope, R. N. Hazard, W. A. Anthony, Elihu Thomson; managers, A. C. Fowler, S. S. Wheeler, E. P. Thomson, Joseph Metzler; secretary, R. W. Pope; treasurer, Geo. M. Phelps, jr. This organization, at its annual meetings, presents a programme of scientific interest, and several of the papers read we publish in this issue of the REVIEW.

At a village in Styria there are some remarkable caves containing stalactites of great beauty. Herr Kraus, upon whose property these caves are situated, has placed a turbine in a neighboring stream, and utilizes the power to light the caves with fifteen arcs. The effect produced is said to be wonderfully fine.

Fig. 1.

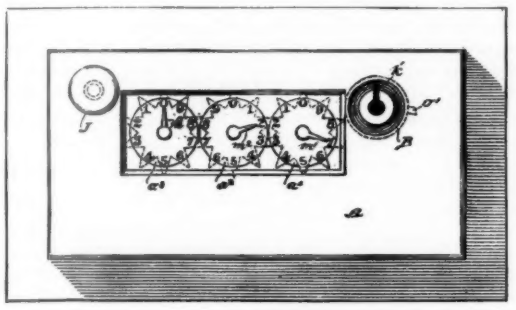


Fig. 2.

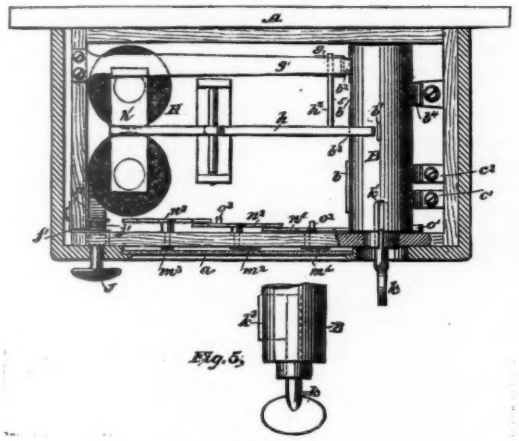


Fig. 5.

Fig. 4.

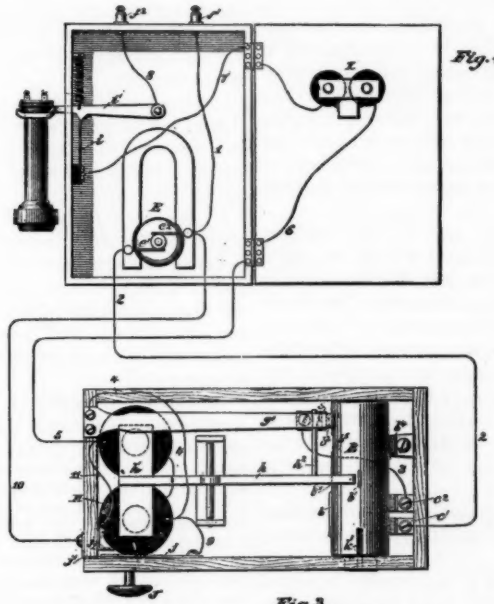
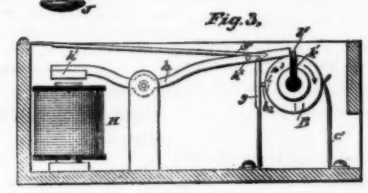


Fig. 3.



DIAGRAMS SHOWING A NEW TELEPHONE CALL REGISTER, DESIGNED BY MR. A. F. ADAMS, LITTLE ROCK, ARK.

Arrangement of Storage Battery Plants

By Edward P. Roberts.

READ AT THE MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, MAY 18, 1887.

Since I had the honor of reading a paper on storage batteries at the annual meeting of 1885, we have discarded storage batteries distributed in various localities as the source of supply of current to our incandescent lamps, and have now all lamps connected with our incandescent dynamos. Having, however, a large number of cells, we have placed in position at our station about 1,200 of the same, charging them at night and using the stored current for day lighting and power, both of which are small in amount. In case of an accident to our machinery at night we could use our storage plant to tide over the time required for repairs, or until the majority of lights could be turned off. We have not yet had call, however, for such service, although we always have the batteries charged to a considerable extent before dark.

Since 1885 we have tried crockery and glass cells, with plates suspended in the same from glass rods and separated by glass rods from each other. This was a great improvement. The cells are placed on beams of a triangular cross-section, having a four inch base, which, in turn, rest on glass insulators, Western Union pattern, screwed on pins fastened on cross pieces. The beams are first painted and then given a coat of paraffine. The insulation from cell to cell is much improved thereby. When lead cells are used they are placed on porcelain insulators on the beams; flat places being cut on the vertical angle of the beam.

I am informed, that storage batteries have been much improved, lately, but, even if such should be the case, I should hesitate to use them where gas lighting is cheap and where it might be desired to use only a few lights in each of a large number of localities separated by considerable distances. For special cases, however, I have no doubt the storage batteries can be used advantageously, particularly when the advantages of incandescent electric lighting are considered as being of financial value.

A few of the disadvantages arising from the conditions in the first part of the above paragraph, are:

1. A large plant in each locality is needed because of possible drain on same. The ordinary use in a residence may be 15 lamp hours and the possible use 100 lamp hours. This is an extreme example, but is not exaggerated, as it was the necessary margin we had to provide, when we had storage plants in each house requiring light, for from 15 to 20 per cent. of our customers.

If several customers can be supplied from one battery plant the margin of extra supply can be reduced. In such case it will be necessary either to connect all the customers on all the batteries connected in multiple arc, and then disconnect the batteries and charge same in series, or, if it is desired to use a meter system in which discharge bears a certain proportion to charge, an attendant must be ready to throw extra batteries on circuit needing same, and note name of customer using extra supply.

2. A large number of plants means a number of small stations to maintain and at which to keep supplies—distilled water, acid, etc.

3. With a number of small stations it is difficult to regulate E M.F. to current desired. However small the percentage of E.M.F. lost in the discharging wires, the E.M.F. of the batteries should rise as lamps are turned on, or the lamps will be below candle power, when a number are used, if for one or two the proper E.M.F. is used; or it will be necessary to strain the lamps when a few are used, in order to have normal brilliancy when a number are desired. To still further complicate matters, the E.M.F. is higher at the start, particularly if only a few lamps are "on," than it is later in the evening. These differences in E.M.F. are small, but are sufficient to vary the candle power of the lamps.

If, therefore, each customer is connected with one or more batteries for his sole use the following takes place: As darkness approaches one or two lights are turned on and are raised to abnormal candle power, straining lamps and making consumers dissatisfied with any less light later on, and as the customer's eyes become tired the light drops, possibly not below the normal candle power, but the comparison is bad, and it requires considerable power of persuasion on the part of the company's "talker" and loss of his time as a "worker," to make the customer believe that his eyes are at fault, and not the light. It may be that an entertainment is given in the house, and then the drop of candle power is more noticeable, although it may not fall much below the normal.

Of course it is possible to design mechanism to overcome all such troubles, to throw in extra cells and extra batteries as required, etc. To design mechanism to accomplish such work with reliability, and which will not be too costly for maintenance, or prohibitory on account of excessive first cost, is considerable of a problem. Matters are further complicated by the necessary use of charging mechanism. Also, it is desirable to have switches so arranged that it will be impossible to have charging current "on" when lights are being used *from* a battery. The writer has run 1,000 lights in such a manner (with charge on) for over a year, but does not advise it from any standpoint except necessity.

If a few large stations are used the E M.F. at same can be readily shown at main station, and regulated from same if desired, or an attendant can be sent to any station needing regulation.

My experience teaches me that if batteries can be charged under inspection and allowed to have a discharge without excessive variation in amount of same, that the batteries will give much more reliable results than in any other way. The nearer this can be approached the more satisfactory will be the service.

If, therefore, it seems to be advisable in any city to erect a storage battery system for general distribution, I believe it will be found best to erect a very few large battery stations at the various centers, and that the interest on the extra cost of the wire leading from the same to the lamps, over what would be necessary if each light were close to a battery, will be far more than saved in the lessening of attendance alone; and that the avoidance of other evils I have mentioned will thus be clear gain.

Cheyenne, Wyo., April 5th, 1887.

On the Differing Temperature Coefficients of the Different Coils of a Fine Rheostat.

BY PROF. W. A. ANTHONY.

READ BEFORE THE ELECTRICAL ENGINEERS.

The title of this paper should rather have been "A Description of Experiments by which the Differing Temperature Coefficients of the Coils of a Fine Rheostat were Discovered." I thought the experiments of sufficient interest to warrant a description, and I find, on writing the paper, that the experiments occupy the greater part of it.

In 1884 the Cornell University ordered of Latimer Clark, Muirhead & Co., of London, a fine rheostat and bridge of special construction. Among other things it was specified that the resistances of the coils of both bridge and rheostat should check among themselves to $\frac{1}{100}$ of one per cent., and that everything should be done to make the instrument as accurate and reliable as it was possible for such an instrument to be. On its arrival it was found not to fulfill the requirements as regards accuracy, the coils differing among themselves in many cases by more than $\frac{1}{10}$ of one per cent. It was returned to the makers for readjustment and did not come back to the University for several months. On its return it was found that the adjustments had been much improved, but still did not come within $\frac{1}{100}$ of one per cent. It was, however, finally accepted at a reduced price, the writer proposing himself to perfect the adjustment. Press of other work prevented this being done, and last November, when a problem requiring the highest attainable accuracy in the comparison of two resistances presented itself for solution, this rheostat was used for making the comparison, it being proposed to afterward determine and apply the corrections for the errors of the individual coils.

The problem was, to find by experiment the ratio of the constants of the suspended and stationary coils of the large galvanometer, a description of which has already been read before the Institute. The constants of these coils were determined by measurement while they were being wound and the experimental determination of the ratio was undertaken as a check on the measurements. To determine this ratio, a current is made to divide between the stationary coils on the one hand, and the suspended coil on the other, but in the reverse direction, so that the two currents shall have a differential effect on the needle. The resistances are then adjusted till the needle is unaffected, when the current in both branches is reversed. The constants of the coils in the two branches are then directly proportional to the currents flowing, and, therefore, inversely proportional to the resistances of the two circuits.

To obtain the ratio of these resistances, they were arranged as two branches of a Wheatsone's bridge, as shown in Fig. 1, the other two branches being made up from the rheostat referred to above. The apparatus was arranged and the tests made by Mr. Ryan, a senior in electrical engineering, and Mr. Hammon, a graduate student of electrical science.

The first trials showed that nothing could be done with binding, screw connections and sliding contacts. All permanent connections were therefore soldered, and all others made with mercury. After this was done, irregularities still existed which were traced to varying temperatures, resulting from the fact that the building in which the galvanometer is mounted is of wood and warmed by a wood fire in an "air-tight" stove. The fire was allowed to go out, and the work continued at the temperature existing outside, about zero Centigrade. Times for the experiments were chosen when the temperature was quite uniform, and the results were found to agree very well among themselves, but, to our surprise, they were to ally different from the results obtained at the higher temperatures. The table below will show how the results ran:

—Room Warmed.—		—No Fire in Room.—	
Temp.	Ratio.	Temp.	Ratio.
21.4	2.9520	Dec. 7..1.7	2.9492
21.3	2.9523	1.7	2.9492
20.8	2.9529	1.8	2.9492
20.3	2.9534	1.6	2.9492
20.2	2.9526	Dec. 8..3.7	2.9495
20.2	2.9528	3.8	2.9498
19.1	2.9529	3 8	2.9497
		3.8	2.9497
		etc.	etc.

Here is a difference of one-tenth per cent. for a change of temperature of about 20 degrees Centigrade. It should have been stated that the ratios above are the ratios of the two resistances as read from the rheostat; that one of the resistances was always 1.000, and of the other, which was nearly 3,000, only the units and tenths coils were changed.

A study of the construction of the galvanometer, and a discussion of the effects of temperature upon it, made it clear that the change indicated above could not be a real change in the ratio of the constants of the coils. It must, therefore, be looked for in the rheostat. To test this conclusion, different sets of rheostat coils were used in making up the arms of the balance, and tried at high and low temperature. In one case the ratio was apparently larger at the lower temperature, the reverse of the result shown in the tables above. But the crucial test was suggested and tried by Mr. Ryan. He took the rheostat out of doors and then subjected the galvanometer and all accessory apparatus, except the rheostat, to changes of temperature. The rheostat then indicated the same apparent ratio for all temperatures of the galvanometer.

It is certain, therefore, that a change of temperature of 20 degrees causes a change in the relative resistances of two sets of coils in this rheostat to the extent of $\frac{1}{10}$th of one per cent., that is, the temperature co-efficients of the different coils are not the same, and it is, therefore, no wonder that the makers could not adjust the resistances more accurately. Such differences of temperature co-efficients might well occur if the wire of which the coils are wound was taken haphazard from different lots, made, perhaps, from different lots of metal. If makers of fine instruments are not careful to select wire that is sure to be of one composition for the construction of resistance coils, it is no wonder that it is so difficult to attain to a high standard of accuracy in electrical measurements.

But there is another possible explanation for the differences found in this instrument. The low resistances are of coarse wire, and this, from different temper or from different treatment in drawing, might not have the same co-efficient, although made from the same metal, as the fine were. In short, I believe that, for the construction of an accurate rheostat, the coils should not only be from the same lot of metal, but should all be drawn to the same size and subjected to the same treatment while being drawn. The wire chosen should be fine enough for the coils of highest resistance, and coils of low resistance should be made by winding two or more of the same wires in multiple arc.

Isolated Electric Lighting.

There has been a pleasant rivalry between the Boston and New York representatives of the Edison Company in relation to the number of electric lights contracted for. Mr. C. A. Benton, of New York, agent for the Edison Company, reports the following new contracts made within the past thirty days, and if Boston can do better, a pretty lively showing will have to be made.

Western Union Building, 195 Broadway, takes one 400-light dynamo for lighting, and besides uses sixteen 50-light Edison dynamos (specially wound) for replacing battery current on the telegraph lines. A Straight Line engine is used for this plant.

The Gallatin National Bank, Wall street, has ordered a 250-light dynamo, to be run direct from a Brotherhood engine.

The United States Assay office, Wall street, will be made happy with a 60-light dynamo.

B. T. Babbit, the soap manufacturer at Washington and Rector, has ordered a 100-light dynamo.

The Harmonic Club, New York, has contracted for two 250-light dynamos, and will use Straight Line engines The Club has constructed a separate building in which the steam power will be located, and the electricity will be generated. This plant is a duplicate of the one in the residence of Mr. Whitelaw Reid, the engine and dynamo being duplicated, so that accident need never interfere with the lighting.

Among other contracts are the following: 900 lights for Swarzchild & Sulzberger Refrigerator Company, Forty-Fifth street and First avenue; Mechanic's Building, 2 and 4 Stone street, 200 lights, a Ball engine furnishing the power; Adams & Son, Brooklyn, one 75-light machine; Havermeyer Sugar Refinery, Greenpoint, N. Y., 50 lights; Manhansett House, Shelter Island, a 150-light machine, replacing arc light; an increase of 500 lights at Stern Bros., on Twenty-Third street, New York; Geo. S. Scott's yacht, Stranger, 80 lights, from a 50-light dynamo.

—— The Petitt Flouring Mill, of Minneapolis, Minn., was lighted for the first time with its new electric light system Monday last, and the men in the mill now do not see how they ever got along without it before. There are about 70 incandescent lights distributed over the building, and they light up corners and places seldom in the past illuminated except by lantern. Jacob Kupfer, the engineer, will look after the operation of the dynamo.

Bleaching by Electricity.

The subject of bleaching by electricity continues to attract much attention. The *Journal of the Society of Chemical Industry* for March, 1887, contains a communication by Cross and Bevan upon M. Hermite's process for electrolytic bleaching. Before discussing this article a few matters connected with this subject should be considered. The process in every form depends upon the conversion of power by means of the current from a dynamo into available chlorine by the decomposition by the current of some substance capable of furnishing chlorine or its oxides. For this decomposition chloride of magnesium is the most suitable substance yet found. The problem presented is to accomplish this decomposition economically, and the question to be answered is: Can power thus used compete with bleaching powder at its present price? This question will be considered at the close of this article.

In the Hermite process (Eng. Pat. 13,929, October, 1864), a solution of chloride of magnesium of 25° Tw. is said to give the best results. A solution of chloride of calcium of 38° Tw. can be used. The connection with the dynamo is made by negative electrodes consisting of zinc plates bolted together and soldered to copper rods. The positive electrodes are plates sunk into wooden frames, and also soldered with copper rods. It would seem preferable to prepare the solution containing the available chlorine in a decomposing tank, and then transfer it to the place of use, but the goods can be dipped in the decomposing tank.

Cross and Bevan discuss first the superiority of bleaching powder over other oxidizing agents, as permanganate of potash and hydrogen peroxide, and conclude that electricity must compete with bleaching powder if it is to be used. They state that by the electrolysis of magnesium chloride a mixture of very high bleaching or oxidizing power is produced. It contains hypochlorite of magnesium, hydrogen peroxide and a higher oxide of chlorine. The efficiency of bleaching powder is measured by its oxidizing power. Cross and Bevan claim to have proved by experiment that with equal oxidizing power or available chlorine the bleaching efficiency of the electrolyzed chloride of magnesium solution is twice as great as that of a bleaching powder solution. They consider this peculiar and important fact due to the rapidity of action and the small consumption of bleaching oxygen. They consider that with the electrolytic solution the bleaching action is confined more closely to the impurities on the fiber and the fiber is left more perfectly intact. This should exert an important influence on the strength of the goods. Cross and Bevan find by experiment that it will require 570 horse power to produce 100 kilos of available chlorine per hour. This is equivalent to 6 cwt. of bleaching powder per hour with 570 horse power. But Cross and Bevan state that this amount will do twice the work done by an equal amount of chlorine in bleaching powder, hence we shall have 12 cwt. of bleaching powder per hour with 570 horse power. The results obtained with calcium chloride are not so favorable.

In the usual method of bleaching, the bleaching liquor is exhausted as far as possible and then allowed to run to waste, but this exhaustion is far from perfect and much available chlorine is wasted. If the strength of the bleaching liquor could be maintained the loss would be very small. Hermite's system allows a maintenance of any desired strength in the bleaching tank by circulating the bleaching liquid from the decomposing tank into the bleaching tank and return. This bleaching liquor gives excellent results, according to the authors, not only on cotton, but also on linen and paper pulp. "We may sum up our experimental results in this province as follows: On the electrolytic system the consumption of chlorine is one-half that on the ordinary system; owing to the greater efficiency of the bleaching we are able in certain grades of bleaching to suppress one or more of the alkaline treatments, in which case the loss sustained by the yarn is less; in all other respects the results on the two systems are very similar."

In figuring the cost of the process Cross and Bevan call 570 horse power per hour, equal to 10 cwt. of bleaching powder, when 50 horse power will equal about 1 ton of bleaching powder per 24 hours. Taking the cost of 1 horse power at £9 per annum, and calculating on the basis of 300 days, the cost is £1 10s. per ton of produce per power. The cost of special apparatus is figured at £2,100 per ton, per day, with 50 horse power engine, not included. Taking 15 per cent. for interest and depreciation, these items will amount to a little more than £1 per ton of bleaching powder. There is, of course, the waste of chloride of magnesium to be considered. It appears from this article that if bleaching powder costs over about £2 12s. per ton, in England, the electrolytic process is cheaper. Bleaching powder is now quoted at 9s. per cwt. in the warehouse in England. This leaves a very handsome margin of profit for the electrical process, but it must be remembered that the calculations of Cross and Bevan do not include any royalty for the inventor of the process, and are to be considered as a favorable view of it.

How will the process compete with bleaching powder here in the United States? As is well known, the price of bleaching powder is very little higher in our Atlantic ports than it is in England. The cost of power here is a very variable factor. Steam power is in most places somewhat more expensive than in England, while water power is often cheap. Machines suitable for this work and the plant in general will be more expensive here than in England. These causes will tend to make the process on the whole more expensive here. Any manufacturer who knows approximately the cost of his power can gain an idea from the figures given of the value to him of this process. It will be safe to add to the cost of plant as given above 25 per cent. on account of the different circumstances here. We shall record from time to time the development of the process.

Abstract of "The Lighting of Private Houses by Electricity."—E. Hospitalier.

The methods proposed, tried and put in practice the past few years to accomplish the lighting of private dwellings by electricity have been so numerous and different that we have thought it worth while to make a classification, based upon the nature of the source of electricity employed; for the difficulty is not with the source of light, which is an incandescent lamp of greater or less power, but in the distribution and production of electric energy to supply these lamps.

We are led to make two divisions — the first, in which the current is supplied from a central station direct or by the aid of translating devices; second, in which the current is produced on the spot.

A.—Central Stations.—It is well understood that in these stations invariably electricity is generated by the expenditure of mechanical work, and that the distribution is direct or indirect by the aid of transformers in operation at the time or not, as the case may be, for the purpose of modifying the current supplied to the consumer, to simplify the conditions of supply, and to furnish current while the central station is not in operation.

The following table comprises the principal methods employed or proposed. That which will undoubtedly be used in the future, but which is now not much employed, is the distribution by storage batteries with varying methods of connection, so that charging may be done with high electromotive force at a distance by one or more stations, and the establishment of centers of distribution at a low potential, according to the amount of lighting in each part of the town. The high cost of storage batteries and their rapid depreciation does not allow us to place great hopes in this method of distribution. Converter systems are in operation only at the same time with the central station; a storage battery system is too expensive:

SYSTEMS OF DOMESTIC ELECTRIC LIGHTING.

A.—CENTRAL STATIONS.

a. Direct Supply.

Constant potential.	Direct current.	65 volts (Auvers). 100 volts (Edison). 200 volts (Edison 3-wire system).
	Alternating current.	Different potentials (Gordon, Paddington Station).
Constant current.	Thomson-Houston. Bernstein.	

b. Indirect Supply.

Converters or translating devices.	Alternating currents.	Gaulard & Gibbs (constant current). Zipernowsky & Deri (constant potential).
	Constant current.	Robinet de Cabanellas. Transformers of Scott & Paris.
Storage systems.	Storage batteries charged and discharged in series (d'Arsonval). Storage batteries with varying connections. Storage batteries distributed when charged. Distributions of plates and acid (as proposed by Union Storage Battery). Charging of stationary accumulators by the use of other charged accumulators.	

B.—ISOLATED PLANTS.

a. Motive Power Employed.

Direct system.	Steam, gas, water, vacuum or compressed air engines.
Indirect system.	Storage batteries charged at stated intervals by a machine driven by one of the above prime movers. Self-movable engines coming to charge at a stated time.

d. By Chemical Means.

Direct system.	Intermittent use.	Bichromate of potash batteries (Radiguet), moving liquid cells (Baudet), Leclanche cells with large surface, Lalande & Chaperon's cell, portable cells (Trouvé, Schanschieff).
	Occasional use.	One liquid bichromate cells, Erhardt & Volger battery, portable lamps.
Indirect system.	To be used when desired.	Storage batteries charged by liquid. Circulating cells, or bichromate potash, or soda cells. Chlorine battery (upward). Sulphate of copper cell (E. O'Keenan).

The project of the Union Storage Battery Company is to cart dry accumulator plate, replacing at the house or store of each customer the discharged by freshly-charged plates, and restoring the amount of acid absorbed by the plates during their discharge. This method is as novel as it is impracticable. The transportation of accumulators already charged is of some use, and is much employed during the winter in the large cities for dinner parties, receptions, etc. But this is not properly called a method of distribution. In some cases, in permanent installations, the experiment has been tried of bringing freshly-charged cells to replace those discharged, but the cost per horse power available demanded is up to the present time prohibitive, and much above that of primary batteries.

If not near a central station for lighting, recourse to batteries, or some form of motive power must be had. Gas engines are much used, and it is well to take advantage of sources of power close at hand. In like manner, compressed air, or vacuum methods of distributing power, may be employed where they now exist. But it is not desirable to establish such plants to distribute power for electric lighting, when a central station for the direct supply of electric current could be established.

The method of bringing a self-driving engine to the local plant on certain days is worth mentioning; the cost, however, has never been estimated.

For small experimental plants only the use of batteries for electric lighting is practicable. The experience of three years has led us to reject any system employing accumulators charged by batteries continuously in use.

All primary batteries have too much internal resistance—are not sufficiently constant for direct use in incandescent lighting.

The best cell for charging accumulators is a two-liquid cell using bichromate of soda; the upward battery is economical, and the O'Keenan is the simplest.

—— A Safety Car Heating and Lighting Company has been formed with headquarters in Jersey City. The capital stock is $1,000,000. W. C. Andrews, and others, are the incorporators.

ELECTRIC LIGHT NEWS

—— The Clinton Electric Company, Clinton, Mo., has been incorporated. Capital stock, $18,000. George Hormeyer, and others, incorporators.

—— The Hamilton Electric Light Company, Hamilton, Ohio, has been incorporated. Capital stock, $50,000. Thomas Millikin, and others, incorporators.

—— The Manhattan Electric Company, Manhattan, Kas., has been incorporated. Capital stock, $25,000. George Higinbotham, and others, incorporators.

—— The Halifax Gas Company, Halifax, Nova Scotia, one of the oldest and most conservative gas companies on the continent, has just contracted with the American Company for a 100-light plant.

—— Mr. M. T. Davidson, the widely known pump manufacturer, is having a pump built in combination with one of the Sprague electric motors, from which both he and Mr. Sprague expect most satisfactory results.

—— The Westinghouse Electric Light Company, Pittsburg, Pa., has received the contract for a large electric light plant to be erected at Denver, Col., and to consist of 6,500 lights. The station will be supplied with five dynamos, with a capacity of 1,300 lights each.

—— Residents in the upper west side of the city are shouting for electric light on their streets. Taxpayers and householders are agitating a scheme to have a mass meeting favoring the project, and a petition will be presented to Mayor Hewitt within a few days asking for his assistance in the matter.

— Electric whistles, very melodious in sound, and said to be less expensive in manufacture than electric bells, are being favorably received in France. The whistle is made by fitting a small brass tube with suitable apertures so that it opens against the spring of a suitably formed commutator, or circuit "make and break."

—— The Pittsburgh Electro-Plating Company is erecting works at Apollo, Pa. They will copper-plate steel sheets on one side and tin-plate them on the other. This material will be used for making all kinds of stamped ware for household uses, as well as for many other purposes. This is said to be the first large establishment of this kind started in this country.

—— ELECTRIC RAILROADS.—Los Angeles, Cal. The Council has passed a resolution requiring electric railroads to have the wires underground in future instead of on poles. ——Pasadena, Cal. An electric railroad, on the Enos suspension system, is to be built to Santa Monica, a distance of 20 miles. —— Ithaca, N. Y. Electricity will be adopted for the street railroad; the Safety Electric Railway and Power Company will furnish the plant. ——Reading, Pa. The Perkiomen Avenue Railway Company will convert that line to an electric system. ——Camden, Me. Hon. J. B. Stearns proposes to establish an electric railroad to Rockland. ——Scranton, Pa. The electric railroad system is to be extended. ——Lima, O. Work has been commenced on the electric railroad.

—— The Boston Gas Light Company has reduced the price of gas from $1.50 to $1.40 a thousand feet. How much reduction really reduces the price of gas is one of the conundrums that puzzles the consumer, especially when he finds his gas bill just as large as for the month previous to the reduction. Perhaps the reduction in the price may have made the consumer more careless in the use of gas; and then again perhaps the gas company may have put on a little extra pressure upon the gas holder by which an extra amount of gas would be forced through the burner without any corresponding increase of light; possibly there may be a "combine" of both these causes, which in effect would leave the matter in *statu quo*, which would enable the gas company to "eat their cake and keep it too."

Death by Electricity.

By M. A. d'Arsonval.

In preceding papers* I have shown the physical causes of the dangers of dynamo-electrical machines. At that time I had only small laboratory machines at my disposal. Thanks to the kindness of Prof. Mascart and M. Hippolyte Fontaine, I have recently been able to study the question from a practical point of view, and pursue my experiments at the Collège de France with continuous and alternating current dynamos.

I have taken advantage of these circumstances to make a comparative study of the dangers presented by the different sources of electricity. My researches have been directed successively to the physiological effects of:

1. A static machine (Holtz, with four disks) charging a battery.
2. A battery of 420 volts.
3. Continuous current Gramme machines.
4. Alternating current Gramme machines.
5. Extra current or induction coils, either associated or not with static condensers.

To complete this series I ought to have studied the effects of transformers, which are beginning to enter into the domain of practice, and the effects of which are formidable in a way quite different to those of the preceding machines; but this omission will soon be rectified, thanks to the kindness of M. Picon, chief engineer in the Edison workshops.

With all the sources of electricity enumerated above, death may be caused by placing oneself in certain conditions. This death is accompanied by very variable phenomena and injuries, according to the manner in which it has taken place. In this note I will confine myself simply to showing the practical conclusions to be deduced from my experiments. I found that the very varied effects of electricity on living creatures may be classed into two principal categories which include them all. Electricity causes death in the two following ways:

1. By direct action (the disruptive effects of the discharge acting mechanically, so as to distort the tissues).

2. By reflex or indirect action (acting on the nervous centers, the irritation of which brings about the infinite variety of effects so thoroughly investigated by M. Brown-Séquard, under the names of inhibition and dynamo-genie). This simple distinction, resulting from a careful observation of facts, is also of practical value, in that, in the first case, death is certain and definite, whereas, in the second, experiment has shown me that very often the victim may be restored to life by practicing artificial respiration immediately after the accident.

Although I cannot here dwell upon this subject, I will briefly mention the dangers of the different electrical sources.

1. The static discharge is only fatal when the bulb is struck directly with well localized discharges, the energy of which correspond in my experiments to about three kilogrammeters. Under these conditions, the different tissues (nerves, blood, muscles, etc.), when struck singly by the discharge, lose irremediably their physiological properties.

If the discharge has not the force required in order to distort the bulb mechanically, it acts by exciting it, and produces the phenomena of respiratory inhibition, inhibition of the heart, sub-pleural ecchymosis, pulmonary emphysema, paralysis, stoppage of circulation, etc., which M. Brown-Séquard has obtained by directly irritating the *bulbaire* region by excitations of various kinds. Contrary to what is generally believed, it is very difficult to kill an animal by shocks. These secondary effects are not, therefore, the work of electricity itself.

2. With the battery of 420 volts, death is only caused by frequent and prolonged interruptions of the current. It is due to the tetanic condition provoked by the current, rather than to the direct action of electricity. Later on I will enter into the effects produced by a battery of 2,000 to 2,500 volts.

3. The continuous current Gramme machine is only dangerous, as I have mentioned in my former paper, from its extra current on breaking. I have ascertained that compound machines, or doubly-wound machines, give less powerful shocks than machines excited in series or series dynamos. The extra current of a series dynamo, giving 20 amperes and 45 volts, killed a guinea-pig, whereas the extra current of a compound machine, giving 20 amperes and 45 volts, produced no harmful effect. This difference is explained when we consider that the second coil serves as a derivation wire. I succeed in suppressing this extra current by breaking the circuit gradually by means of a simple stoneware tap containing mercury, which serves to cut off the circuit.

4. An alternating Gramme machine only causes death above 120 volts of mean difference of potential.

5. An extra current coil is more dangerous than an induction coil, especially if it is coupled with a condenser.

The danger of an insulated discharge is defined solely by the electrical curve of that discharge. The knowledge of the difference of potential and the average intensity is not sufficient; the duration of the discharge must also generally be taken into account. For the purpose of analyzing the physiological effects of electricity, I some time ago designed an apparatus which registers automatically this electrical curve of excitation, a curve of which all the parameters may be made to vary singly and at will. We thus can easily dissociate the effects of the electrical excitant; I will return to this point later.

It is the same with alternating currents, in which we must also take into account the frequency of the reversals. As I cannot dwell upon this now, I will confine myself to saying that under the conditions usually realized in the industrial arts the current kills by reflex action. And I have succeeded, in the majority of cases, in restoring to life animals that have received shocks, by subjecting them to artificial respiration.

The practical conclusion to be drawn from this note is that it is necessary in electrical works to be able to practice at a moment's notice artificial respiration upon any one who has received a shock, for by this means there is a good chance of restoring him to life.

The currents employed for industrial purposes up to the present most often kill by stoppage of respiration. Artificial respiration, by preventing asphyxia, enables natural respiration to be re-established.

M. Brown-Séquard, in reference to M. d'Arsonval's communication, offers the following remarks upon the treatment of loss of respiration.

M. d'Arsonval might have said that for several years we have successfully employed at the Collège de France a mode of excitation having great power in bringing back respiration stopped by inhibition. This process is far superior to trans-current cauterization, which is employed by Faure and other experimentalists. It consists simply in the application of a faradic current to the sides of the larynx on the skin, which is moistened or superficially incised.

We know that in laboratories galvanic shocks are given with a certain amount of success at any point, to restore respiration in animals in which that function has been stopped under the influence of chloroform or by other means. We have found in comparative experiments, which remove all doubt, that of all parts of the body that which, being galvanized, has the greatest power in restoring respiration, is the one we have mentioned. There is a very natural reason why this should be so; by the faradization of this part the nerves (*les nerfs vagues*) are slightly irritated, which, as all physiologists know, is a cause of respiration, and even sometimes of a considerable increase of respiratory energy.

* See *Comptes Rendus* for January 26th and March 9th, 1885, and also *Société de Biologie* December 20th, 1881.

Practical Notes Concerning the Construction, Use and Management of Storage Batteries.

By A. Reckenzaun.

Analogy between Hydraulic and Electric Accumulators.—Some 40 years ago the first hydraulic crane was erected on a quay at Newcastle, and this crane had to work with a constant head of water 200 feet high in order to produce a pressure of about 90 pounds per square inch upon the rams which moved the chains. To keep this pressure up, the water had to be pumped into a tank at the height indicated. It was some time after this, when Sir W. Armstrong discovered that if water be pumped into a pipe or cylinder fitted with a movable plunger, and if that plunger be loaded with weights, the enclosed water was in exactly the same mechanical condition as if it were in communication with a reservoir many feet above it. In either case the water is under pressure, whether that condition is caused by a load of metal or a load of water. The vessel which stored the water has been called an accumulator, because it actually accumulated the power of the steam engine, and it returned that power at a constant weight whenever requisite. The pumps worked by the steam engine supply the accumulator with water as fast, or nearly as fast, as the same is consumed by the hydraulic rams. So long as there is any water at all within such a cylinder containing a weighted plunger, there will be a constant pressure maintained. The stroke of the plunger, or the diameter of the cylinder, or, more correctly, the capacity of this hydraulic accumulator, had to be arranged in accordance with the supply and demand of water under pressure. If the demand is regular and the supply somewhat irregular, then this capacity must be large in proportion.

In the case of electric accumulators we have also to proportion the capacity according to the irregularity of the dynamo, or electric "pump," but that irregularity must be kept within very narrow limits; whereas the number of strokes of the water pump may for a few moments be reduced to an exceedingly low number; so long as the smallest quantity of fluid remains in the accumulator there will be a constant pressure due to the weight, while in the case of the storage battery a comparatively small reduction of speed on the part of the charging apparatus will cause a discharge of electricity from the accumulator into the generator. It is this great sensitiveness of the dynamo which renders the secondary battery statically unlike the hydraulic accumulator. When the supply ceases, the pressure of the hydraulic accumulator is practically constant until the last drop of water is squeezed out; with the battery, on the other hand, the pressure decreases considerably before the cells are entirely discharged.

Constructive details.—The Faure Battery.—We come now to the most difficult, and at the same time the most important part of our subject. The success or failure of a secondary battery depends upon minute and apparently unimportant details of construction. One could scarcely imagine a simpler apparatus than, for instance, an original "Faure" battery, which consisted of sheets of lead, the surfaces of which were covered with a thin paste of red lead and the whole rolled up with some cloth or felt to keep them apart. This thing worked admirably for a short time, and the invention was hailed with enthusiasm even by the highest scientific authorities when first introduced into this country. Hundreds of tons of this crude form of storage battery were manufactured when it was still in that immature, untried condition. Instead of commencing careful experiments and gradually developing the invention of M. Faure, people at once began to manufacture these cells wholesale, and it was only after thousands of pounds were spent, and after many months fruitless endeavors, that the great defects in this form of storage battery were discovered. Its utility was found to be great, but it was far from perfect. We agreed with Dr. Lodge when he wrote a few years ago that some day it may perhaps be recognized, that because it can be shown that a thing will be extremely useful when perfect, it does not follow that it has already attained that perfection; that, indeed, probabilities based on historical developments are enormously against such abnormal and instantaneous maturity, and that the careful nursing and rearing necessary to healthy maturity are better given in the seclusion of laboratory and study than in the excited and heated atmosphere of the Stock Exchange.

It is doubtless recognized already that all preliminary operations are better conducted on a scale smaller than the wholesale manufacturing one.* In developing a new industry there are scientific difficulties to overcome, and there are manufacturing difficulties. By scientific difficulties, we mean such as the determination of weak points, the best way of strengthening them, and generally the discovery of theoretically the best modes of effecting the object in view; the manufacturing difficulties begin with questions of expediency and economy—how most cheaply and satisfactorily to carry out the indications of theory, to obtain this or that material—and includes the organization of a system of manufacture, of division of labor, of machine tools, which shall enable the work to be done with economy, security and dispatch. Over-haste in the preliminary stages caused both these sets of difficulties to be tackled together, and thereby threw a grievous burden on all concerned. All these untoward conditions have storage batteries experienced; and to say that they have not fulfilled the hopes of their early promotors, is no more than to say that those hopes were untimely and unreasonable.

The main difficulties which were found with the Faure battery were firstly, that the red lead paste would not adhere to the smooth sheet lead; it became detached in flakes; secondly, the wrappings of cloth or felt became corroded with the acid; and thirdly, the separating material, being comparatively dense, prevented the circulation of the electrolyte; the acid was in consequence exhausted in some parts and concentrated in others, altogether there was too little of it in the immediate vicinity of the plates. There was greater activity consequently in some parts of a plate than in others.

The detachment of the oxide coating was not entirely due to a want of cohesion between it and the smooth lead plate. Sheets with roughened surfaces were tried with no better results. The peeling off is partly due to the fact that the acid penetrates through the pores of the coating and creeps up between it and the sheet lead when sulphate is produced, and patches of the substance are by this means rendered inactive, owing to the insulating properties of lead sulphate. The main evil, however, lies in a different direction, and this has probably never been explained; it is this, the paste expands during oxidation and also when sulphating; the minute particles must then travel along upon the surface of the metallic support, which does not expand, and thereby diminish the adhesion of the paste which was originally smeared upon the lead plate and dried before placing it into the box with acid.

Queries and Answers.

To the Editor of Electrical Review:

What is the best material for commutator segments? X. Y. Z.

Answer:—Copper cast, or better forged. By all means do not have a soldered joint in the commutator segment. The particular kind of metal used for brushes is important and should be much softer than the commutator. When two substances not equally hard rub together, the softer wears rapidly away, while the harder suffers little loss. Phosphor or aluminum bronze has been successfully used for commutators, as the wear is almost entirely on the copper brushes. It should be remembered, however, that the conductivity of these alloys is less than that of copper.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING MAY 17, 1887.

363,938 Apparatus for cooling saline solutions; William B Cogswell, Syracuse, N. Y.

362,957 Electro-magnetic thermoscope; Henry J. Haight, New York, N. Y.

363,079 Electrical device for operating steam whistle; William M. Pease, Pittsburgh, Pa.

363,106 Method of and apparatus for forming armature cores; Frank Wynne, Westminster, county of Middlesex, England.

363,126 Self-exciting alternate current electric generator; 363,127, Safety contact brush for dynamo-electric machines; 363,128, Dynamo-electric machine; 363,129, Method of and apparatus for detecting short circuits in dynamo-electric machines; James W. Easton, New York, N. Y.

363,158 Transmitter for electrical typewriters; James F. McLaughlin, Philadelphia, Pa.

363,182 Covering insulated electric conductors; Jas. Tatham, Philadelphia, Pa.

363,183 Electric switch; 363,184, Automatic commutator adjuster; 363,185, Alternating current electric motor; 363,186, Alternating current motor device; Elihu Thomson, Lynn, Mass.

363,188 Telegraphy; Francois Van Rysselberghe, Brussels, Belgium.

363,215 Electric striking device for clocks; Silas C. Dickinson, Wilton, Iowa.

363,250 System of electrical distribution for railways; William J. McElroy, Pittsburgh, and John D. Nicholson, Allegheny City, Pa.

363,304 Pocket battery; Lucius T. Stanley, Brooklyn, N. Y., assignor to Augustus N. Lindsley, Orange, N. J.

363,320 Process of and apparatus for working metals by the direct application of the electric current; Nicholas De Benardos and Stanislas Olszewski, St. Petersburg, Russia.

363,332 Device for attaching and detaching electric lamps; 363,333, Indicator for electric lighting systems; 363,334, Electrical switch; William J. Hammer, Boston, Mass., assignor to himself and Francis R. Upton, Orange, N. J.

BUSINESS NOTICE.

"In making the statements which follow we can verify each and all of them as facts. Mr. Edward P. Thompson, of Temple Court [7 Beekman St.,] New York, is a good man to bring your patent cases to, for he is thoroughly versed in all the ins and outs of a Patent Attorney's duties. The following are some of his qualifications: Graduate of Stevens Institute as Mechanical Engineer. For four years tutor of classes of young men in mathematics and experimental physics at Elizabeth, N. J. Served professionally as Electrician and Chemist in the Swan Electric Company of New York for two years. Because of past successes as a Patent Attorney at 13 Park Row, New York, was appointed, to succeed N.S. Keith, of the patent agency of the *Electrical World* and Associate Editor. N. S. Keith is known as the Translator and Reviser of Schellen's Treatise on "Dynamo Electric Machinery." Mr. Thompson for two years personally prepared and prosecuted all the patent business of *Electrical World's* Patent Agency, and is the author of a series of articles in said paper upon "Analytical and Systematic Method of Inventing," which were widely known and favorably received. Mr. Thompson is a member of American Institute of Electrical Engineers and American Society of Mechanical Engineers. He is author of the "Expansion of Polynomials," which the ablest mathematicians of the world universally commend." —*New York Observer*

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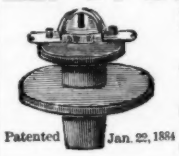
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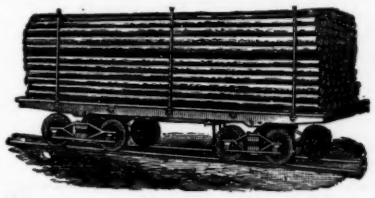

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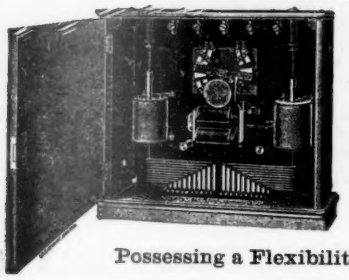

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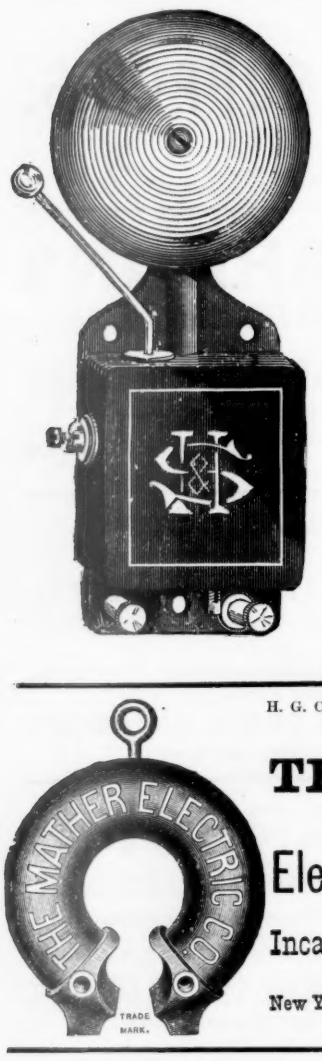

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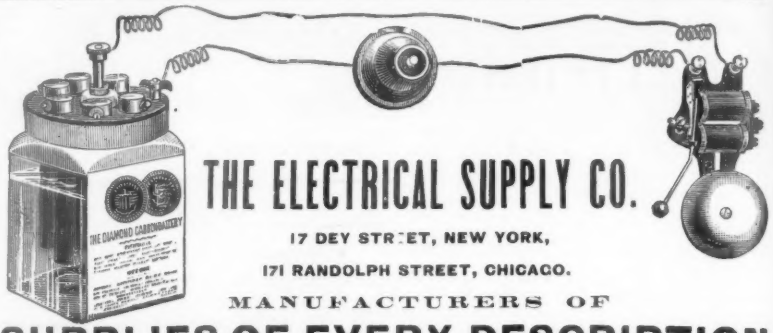

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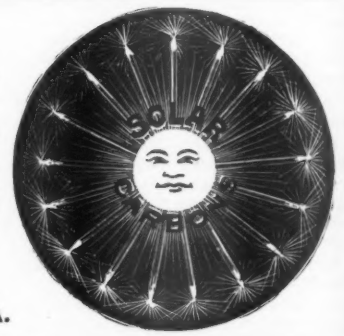

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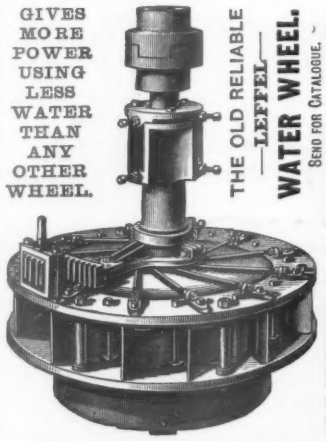

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